Final Project Report

Inventory of Fishes in Inland Fresh and Brackish-Water Habitats of Virgin Islands National Park

William F. Loftus

USGS-Florida Integrated Science Center-Center for Water and Restoration Studies, Everglades National Park Field Station, 40001 State Road 9336, Homestead, FL 33034
305-242-7835, 305-242-7836 (fax)
Email: Bill_Loftus@usgs.gov

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Introduction

The U. S. National Park Service (NPS) created the National Inventory and Monitoring Program to provide funding and technical support to the more than 250 park areas with significant natural resources. The goal of the program is to conduct basic inventories and develop plans for long-term monitoring of those resources. The program supports the inventories of major vertebrate groups and vascular plants in the parks to determine the occurrences and distribution of those natural resources. The goal of the NPS Inventory is to document at least 90% of the species occurring within each park.

Virgin Islands National Park (VIIS) was established in 1956 to protect outstanding scenic values and features of national significance on and around the island of St. John in the northeastern Caribbean. The park now comprises an area of almost 13,000 acres. In 1976, the United Nations Educational, Scientific and Cultural Organization (UNESCO) through its Man and the Biosphere (MAB) program designated the park as a Biosphere Reserve. VIIS has relatively complete checklists for several major taxa to be inventoried under the NPS program. However, distribution and status information are lacking for bats (the only native terrestrial mammals), the herpetofauna and ichthyofauna, marine vascular plants, introduced plant and animal species, native and migratory birds, and marine bait-fishes.

Because of the paucity of fresh and brackish water resources on St. John, there has been little emphasis on inventorying inland aquatic habitats for fishes. Most attention in this island park has been directed towards marine resources. However, resource managers, scientists, and naturalists working on St. John have reported the presence of fishes and aquatic invertebrates in the freshwater streams and estuarine channels and pools (C. Rogers, R. Boulon, H. Waddle, and T. Foster, personal communications; Smith and Brousseau 1996).

Objectives

1. Inventory the inland fishes of VIIS to provide geo-referenced information about fish species composition, richness, and distribution in aquatic habitats on the island of St. John.

2. Measure physical characteristics of inland aquatic habitats.

3. Compare the species composition of the inland ichthyofauna of St. John with sites elsewhere in the Virgin Islands and the Caribbean.

Here I report the results of the inland fish inventory of St. John that was performed from 2001 to 2003. I include all collection data by species, date, and location, with length data for individuals, and site descriptions for all locations visited. This report also includes an ArcView-generated map of all sampling locations, based on coordinates collected with a GPS unit. I also include all ancillary environmental data for habitats sampled. Finally, I present a discussion of the relationships of the VIIS ichthyofauna within the larger context of Caribbean zoogeography.

Geography and Climate

St. John is located in the eastern Caribbean, west of St. Thomas, lying between latitudes $18^0$00'00" N and $18^0$22'30" N and longitudes $064^0$39'30" W and $064^0$48'00" W. Geologically, the northern Virgin Islands, including St. John form the easternmost segment of a landmass on the Puerto Rican bank termed "Greater Puerto Rico". During past sea-level minima, these islands have combined to form one landmass with Puerto Rico, which is reflected in their floral and faunal similarities (Figueroa Colon 1996). The highest point on the island is Bordeaux Mountain at 387 m. The island has a limited area of narrow coastal flats, some with small embayments (salt ponds) or dry salinas. The formation of these habitats and their function in supporting wildlife on the islands have previously been described (Dammann and Nellis 1992, Stengel 1998), but their use by fishes has not. Steep ridges rise sharply from the sea, cut and drained by intermittently flooded channels called "guts". Historical evidence indicates that some of these guts were perennial streams before the island was deforested by European agricultural colonists (Hatch 1972, Low and Valls 1985, Dammann and Nellis 1992). A similar process occurred on nearby St. Croix ((Seaman 1989). Certainly the geomorphology of the gut channels on St. John argues for perennial flows. Loss of forest and soil cover is thought to have reduced the moisture-retaining capacity of the hills, leading to rapid runoff and elimination of persistent flow.

Rainfall is seasonally and annually variable (Table 1). Higher rainfall usually occurs in the summer and autumn months and the largest events are often associated with the passage of tropical waves or cyclones. Winter rainfall may result from the passage of cold fronts moving eastward from North America, which also drops air and water temperatures slightly. Annual rainfall may vary by as much as 900 mm from one year to another (Table 1), again the result of cyclonic or frontal events. Rainfall is responsible for discharge variation through the guts (Table 2) and affects the persistence of water in inland pools and ponds. The salinity in coastal ponds also fluctuates according to rainfall. Rainfall is lower on the southeast coast of the island, and is reflected in lower discharge and lack of persistent freshwater gut pools there (Table 2).

Air temperatures are typical of the tropics, normally ranging from the 20s^{o}C at night to the 30s^{o}C during the day. Water temperatures are likewise warm, ranging from 28^{o}C in May 2002, 24 to 33.5^{o}C in December 2002, and from 25 to 41^{o}C in March 2003.

Previous Studies

Scientific information about the inland fishes of the Lesser Antilles in general, and the Virgin Islands in particular, is scant (Lee et al. 1983). Clavijo et al. (1980) listed a dozen or so species of fishes that have been reported from fresh and brackish waters on St. Croix, U. S. Virgin Islands. Some of these could be expected to occur on St. John. However, some records from St. Croix are for North American mainland species and non-native cichlids that have been introduced. Most of those would be unlikely to occur on St. John because of the absence of suitable habitat. Clavijo et al. (1980) also recorded another 18 species that could be expected to occur in brackish mangrove habitats or ponds on St. John. Miller (1982) reviewed the ichthyofauna of the West Indian islands. Although he did not specifically mention the Virgin Islands, his statements regarding the fauna of Puerto Rico to the west would also apply generally to the Virgin Islands.

Methods

I made four trips to St. John to perform extensive point-in-time surveys of inland aquatic habitats during each visit. Because of the small number of freshwater/oligohaline (0 – 5 PSU) habitats on St. John, I expanded the original scope of the inventory to include most inland aquatic habitats, including those outside the VIIS boundary (Figure 1). Habitats outside the park that also occur inside the park are likely to have the same fishes. For example, some guts outside the boundary of VIIS originate within the park; fishes can move into park sections when rainfall fills those drainages. Similarly, fishes in salt ponds and tidal ponds outside the park probably occur at one time or another in VIIS. However, the presence of fishes in those ponds depends on access and ambient environmental conditions, which vary among sites, and the presence of a collector to sample them at those times. Therefore, inclusion of fish data from habitats outside VIIS in this inventory provides the potential species pool for the park. Species taken outside VIIS should be designated as "Hypothetical but likely to occur" for the inventory.

I sampled at the beginning and end of wet periods, and in the dry season. Trips were timed to take advantage of conditions on the island that maximized fish populations and enhanced sampling efficiency. I selected sampling sites for fish surveys by visiting potentially suitable aquatic habitats, by consultation with VIIS staff and island residents, and from USGS topographic maps and aerial photos. Some sites were visited only once when there was no evidence that could support fishes; other sites that appeared to offer persistent aquatic habitat were visited on each visit to the island to collect samples under different conditions. A two-person team, always including myself and another biologist, visited each site. We recorded each species observed or collected during the time period. We recorded GPS coordinates to identify each site for entry into a GIS system and to allow for repeated sampling. This provided a geo-referenced inventory of fishes within the park. We attempted to sample the entire assemblage of fishes at each site and retained voucher collections for verification of fish identifications.

Aquatic Habitats and Sampling Gear

The most abundant aquatic habitat was the brackish or saline coastal pond (designated here by the initials – CP), in lowland areas of St. John (Table 3). Location and characteristics of many of these ponds were described in a one-time study in the late 1990s (Stengel 1998). Those ponds varied greatly in size and physical condition, particularly the presence of a rocky berm that isolated some from the sea (Figure 2), resulting in hypersalinity (> 35 PSU). Some ponds were connected to the sea by a narrow channel or across a low berm. Those ponds had lower salinities and could support fishes (Figure 3). In several areas, depressions behind the beach dunes would collect water in persistent pools (Figure 4). The largest salt pond on the island was Mandal Pond (CP-04-E) at 9.75 ha (Stengel 1998), which was partly dry during my visits. The smallest ponds were the beach-berm ponds at a few square meters in area.

Several small guts offered oligohaline conditions for aquatic animals on St. John, at least on an intermittent basis. These drainage channels in the hills are similar to the intermittent streams found on the south coast of Puerto Rico (U. S. Army Corps of Engineers 1978) and elsewhere in the Caribbean. I visited the major guts on early trip, usually spending about three hours walking up each gut searching for pools holding water. Because rainfall amount on the island is rather low and seasonal, the drainages usually consisted of isolated pools separated by dry channel segments. To persist during these low-water periods, fishes and other aquatic species must find refuge in the small pools, and possibly in sub-surface water beneath large boulders in the guts (H. Waddle, personal communication; personal observations). At wetter times of year, or when the island is subject to rainfall from tropical waves and cyclones, the guts funnel runoff from the hills to the sea.

Two guts retained persistent pools of water during my visits: Fish Bay/Battery Gut and Living Gut (Petroglyph Pools). I visited each pool with water on all four visits. The guts did not flow during any of my visits, but after heavy rains in December 2001, the pools were connected by flowing water with the sea. During my visits, water was confined to isolated pools in the gut channel (designated here as Gut Pools –GP). There were six major pools in Fish Bay gut below the junction with Battery Gut (GP-03-W (1-6), then several others above the high fall at that junction, in VIIS (GP-03-W (7). Battery Gut, branching to the west, also had several small pools above the fall. In Living Gut, there were two main pools at the Petroglyph site (GP-01-W (1-2). All gut pools were rather small in area (<25 m^2). They were effectively sampled by active methods rather quickly, but were also sampled by passive trapping overnight. The small number and areas of these gut pools enabled them to be sampled on every trip.

Inland ponds (IP) were located away from the coast (Table 3). One inland pond, at Caneel Bay Plantation resort, was once a drinking-water reservoir but now provided freshwater for the purpose of diluting wastewater from a desalinization plant before entering the sea (Figure 5). Some were saline but most were artificial freshwater ponds excavated to water livestock (R. Boulon, pers. comm.) (Figure 6).

The two-person team visited each pond site for varying periods of time. We spent several hours at each site on the first sampling trip until it became obvious that coastal ponds with salinities above 60 PSU were nearly always fishless. Thereafter, we spent less time at those sites, concentrating sampling efforts on lower salinity habitats. In larger coastal ponds, we sampled major sub-habitats (mangrove fringe, open flats, snags, etc.) with a variety of methods, at locations that were picked at random and repeatedly sampled on subsequent visits. I designated sub-habitats within sampling sites by numbers in parenthesis following the location number.

No single collection method was appropriate for all habitats or all times of year. During the initial sampling trip in May 2002, we tested a variety of methods in different habitats. We determined which sampling techniques were effective in stream pools and runs, ponds, and mangrove sites, yet did not harm the small fish populations. Some sites were sampled repeatedly for comparison during the course of this study. Other sites were sampled only once, either because of access difficulties, but more often because they were inhospitable to fishes. Our sampling methods included a combination of passive minnow trapping, gill netting, snorkeling, seining, visual sampling (Frederick and Loftus 1993), and angling with tiny baited hooks. In the coastal pools, we used a combination of angling, visual sampling, cast netting, and trapping. Small and large nylon bag seines with 1-mm mesh were used in gut pools and coastal ponds to capture fishes (Figure 7). In gut pools, we used Gee 3-mm square wire-mesh minnow traps, usually with two to three traps per pool left overnight to obtain a 24-h catch per unit effort (CPUE). This passive method allowed us to collect at more sites than would have been possible using only active techniques. We also used a dip net to capture fast moving fishes and, to capture fishes that did not readily enter traps or seines. I used a dip net while snorkeling in the pools to capture benthic and cryptic fishes that would not enter traps (Figure 8).

Measurements

We recorded each species observed or collected during the site visit. We also recorded GPS coordinates at each site for entry into a GIS system and to allow for repeated sampling. This ultimately provides a geo-referenced inventory of fishes within and outside the park. We measured characteristics of the environment and sampling sites when the site was visited. The date and time of each visit was recorded and the physical conditions at the site noted. I used an optical refractometer to measure salinity of the water between 0 and 110 PSU. In May 2002, I used a handheld thermometer to measure water temperature. During the December 2002 and March 2003, I used a YSI MPS handheld water-quality meter to measure water temperature, pH, dissolved oxygen, and specific conductance. Unfortunately, the conductivity bridge malfunctioned during the March 2003 trip, so data were lost.

We attempted to sample the entire assemblage of fishes within a site. The natural boundaries of the guts or pools constrained the area searched, and this allowed us to return to the same place for repeated sampling. At locations where a sample was taken, I assigned a collection number to associate the sample with that location and date. However, not all collection numbers have specimens associated with them, because some locations had no fish and others produced only sight observations.

Data Input, Analysis, and Reporting

Data were recorded in notebooks and data sheets while in the field at the sampling sites. For data entry, the technician entered the field data and the digital GPS data into Word and Excel files. As part of the QA/QC protocols, I proofed the computer entries against the field notes to insure that digital data delivered to the Inventory Coordinator was 100% complete and accurate when compared to the original field data. The data included time and date of sample, geo-referenced coordinates taken with a handheld GPS unit, water-quality parameters.

I was responsible for the identification of all specimens seen or collected. Nomenclature followed that of Robins et al. (1991), with the exception of *Oreochromis mossambicus* (Trewavas 1984), and *Eleotris perniger* (Pezold and Cage 2002). I followed the familial nomenclature of Parenti (1981) for *Rivulus marmoratus*. I used a variety of taxonomic keys and references to identify the fishes collected (Randall 1968, Dawson 1969, Erdman 1972, Clavijo et al. 1980, Miller 1982, Bohlke and Chaplin 1993, Smith-Vaniz et al. 1999). After identifying the fishes to species and measuring their lengths, I entered the species data into an Excel Workbook. Tables of biological and physical information for each sampling location on each date, with GPS coordinates, are included in this report, and more extensive tables are submitted on an accompanying CD. I also include a GIS map showing the locations of all sampling sites to match to the data in the Excel files.

Voucher Specimens

Each voucher specimen was associated with a collection number that identifies the sampling location, date, method, and environmental conditions under which it was taken. Because of the small population sizes and limited available habitat for the inland fish species, I saved only small numbers of specimens as vouchers, primarily those specimens that expired during collection, or those difficult to identify conclusively in the field. Fin clips of several tropical peripheral-freshwater species were saved for genetic analysis. In the coastal ponds, where individuals of each species are more numerous, I tried to preserve 5-10 individuals as vouchers for small-bodied species and juveniles of larger species. These were fixed in 10% formalin and later transferred to 70% ethanol. For common species, I collected a series from several locations on the island. I tried to photograph specimens of larger species, such as sharks, that were difficult to manage as wet specimens. Vouchers will be transferred to an NPS-identified repository.

Results and Discussion

Of the four trips to St. John between 2001 and 2003, the first was a site reconnaissance trip in October 2001 to select sampling locations, gather preliminary data, and determine effective sampling methods. In May 2002, I made the first trip to collect samples. Although dry-season conditions prevailed, desiccating many of the habitats I observed on the first trip, heavy rains in December 2001 had connected some habitats to the sea, allowing in-migration of juvenile fishes. Rafe Boulon, VIIS resource manager, showed me several additional inland sampling sites on that trip. I collected 12 samples, as well as information on the physical condition of all potential sampling sites (approximately 68). My next trip was in December 2002, following a wet season that was poor in rainfall. I sampled nearly all sites and again collected 19 samples, some with no fish. The final trip was in March 2003, in the midst of the dry season. Although many sites had dried, this offered the opportunity to collect freshly killed specimens of several new records. I returned again with 19 samples.

I identified 68 sites as potential sampling sites, of which I visited 59 at least once (Table 3). Nine were not sampled because they were on private property or were inaccessible because of time and logistical constraints. Eleven sites were dry on all four visits, primarily inland and gut ponds. I collected samples from 11 locations on all four trips to examine changes in composition over time. Fish species assemblages were recognizable in specific habitats and are discussed in the sections describing those habitats.

Coastal ponds: Of the 40 coastal ponds identified (Table 3), I sampled 32 at least once. Twenty-four of these coastal ponds were located in VIIS; 16 were not. Most of the ponds I could not reach (Turner Point, CP-10-E, Newfound Bay, CP-12-E, Mt. Pleasant, CP-16-E, and Privateer Pond, CP-11-E) were identified as hypersaline or dry by Stengel (1998), so sampling would have added little to the fish inventory. Little information on the physical-chemical conditions of aquatic habitats existed for St. John before this inventory. Stengel's (1998) survey of 33 salt ponds on St. John presented data on salinity, degree of isolation from the sea, and vegetation cover. Her salinity data from most of the same ponds I sampled were very similar, indicating the persistence of a narrow range of salinity conditions in specific ponds. Her data and mine represent a baseline for this habitat on the island. In my study, the physical-chemical characteristics of the ponds varied because of ambient meteorological conditions and physical settings of the ponds, but conditions within a site did not vary much temporally (Tables 4–7). Specific conductance measurements varied with salinity, the highest values to 200.7 mS/cm in the hypersaline ponds (Table 6). Lower salinity habitats had corresponding lower values ranging to a minimum of 4.81 mS/cm (Table 6). Water temperatures were always warm as expected for a tropical island, the highest in the two spring samples (29-35^{0}C, with 41^{0}C in shallows at low tide). The coolest temperatures were measured in winter in the December 2002 sample, with lows in the mid-20s^{0}C (Tables 5-7). Dissolved oxygen levels were frequently supersaturated in the cooler waters in the December sample, with generally lower levels in March (Tables 6-7). The values for pH ranged from 7.4-9 in December to 7.5->9 in March. The mangrove site at Maho Bay (CP-08-W) had a very low pH in March (Table 7).

Table 8 presents the physical characteristics of the ponds, including whether they were dry during most visits, if they were isolated by a beach berm or other barrier, whether they were usually moderately (>35-50 PSU) or greatly hypersaline (>51 PSU), and if red mangroves (*Rhizophora mangle*) were common in and around the pond. The presence of strong, healthy stands of red mangrove indicates that a site is not strongly hypersaline or dry for long periods because this mangrove cannot tolerate high salinity or long exposure to drying (Dammann and Nellis 1992, Stengel 1998). Of the 32 ponds I sampled, 17 had no fish. Twelve of these were inside VIIS and five outside the park. Most ponds without fishes were chronically hypersaline (e.g. Europa, CP-01-E, Southside, CP-10-E, and Salt Pond, CP-05-E). Those ponds were isolated from the sea by high rock and coral- rubble berms, with salinities exceeding 100 PSU on most visits. High salinity and lack of access combined to exclude fishes.

The highest species richness of fishes was found in ponds that were mesohaline to slightly hypersaline (e.g. Yawzi Point (Lameshur), CP-02-E, Chocolate Hole, CP-03-W, and Reef Bay Pond, CP-17-E), particularly if they were connected to the sea by an inlet or had a low, permeable berm. Most of those ponds had stands of red mangrove; in fact, if a pond had red mangrove present and was not isolated, it usually had fishes. Coastal ponds with fishes usually had salinities less than 50 PSU. The highest salinity measured in a pond that had fish was 76 PSU, although the three yellowfin mojarra (*Gerres cinereus*) I collected there had recently expired.

I recognized 33 species of fishes, with an additional five taxa identified only to genus, from these coastal ponds (Table 9). In ponds with connections to the sea, a variety of marine invaders were collected. Many of these were juveniles using these shallow, protected ponds as nurseries. These include tarpon (*Megalops atlanticus*), snappers (*Lutjanus* spp.), and yellowfin mojarra. The lyre (*Evorthodus lyricus*), crested (*Lophogobius cyprinoides*), and darter (*Gobionellus boleosoma*) gobies and the sleepers were also common in the coastal ponds, as were white mullet (*Mugil curema*) and needlefish (*Strongylura timucu*). In ponds with inlets to the sea, a number of marine species appeared be transient inhabitants, including grunts (Haemulidae), damselfishes (Pomacentridae), herring (Clupeidae), and silversides (Atherinidae). Collection numbers for coastal pond sites are listed in Table 10, and the numbers and sizes of fishes recorded there are in Table 11.

A few coastal habitats had low salinities, possibly because of freshwater seepage from the uplands (Maho Bay Pond, CP-08-W, Annaberg, CP-23-E, and Trunk Bay, CP-11-W). These ponds were often located in stands of red mangrove, which shaded them and stained the waters. The spinycheek (*Eleotris perniger*) (Figure 11) and fat (*Dormitator maculatus*) sleepers , and the American eel (*Anguilla rostrata*) (Figure 12) inhabited these low-salinity coastal pools. Mangrove rivulus occurred in many of the coastal mangrove habitats that were not hypersaline.

Coastal ponds offered nursery habitat for marine and euryhaline fishes if there was a connection to the sea. Fishes may also enter isolated coastal ponds when they are temporarily in contact with the sea or receive over-wash during storms. However isolated ponds may become less hospitable to fishes over time as salinities rise from evaporation of fresh water. Mojarras obviously recruit into these ponds in fall and early winter – sizes in Table 11. Unfortunately, as the pond dries and becomes increasingly saline, these juveniles become trapped, and mortality occurs. This occurred in East Base (CP-21-E) and Fish Bay (CP-13-W) ponds in March 2003, when large numbers of juvenile elopids, centropomids, and gerreids expired in the drying ponds (Tables 7, 11).

Gut pools: Based on the October 2001 reconnaissance trip, the major guts emptying into Fish and Reef bays appeared to be the only natural drainages that held persistent fish populations in freshwater. I focused my efforts in those guts. I sampled 14 gut pools, five of which had no fishes because they were usually dry. Four of those were within VIIS and one outside the park. Cob Gut (GP-01-E) and Maho Gut (GP-05-W) had limited freshwater pools on two of my visits, but they were otherwise dry or had poor water quality. Those guts may temporally receive an in-migration of juvenile peripheral-freshwater species when connected to the sea, but without persistent freshwater pools with good water quality, those fishes are doomed.

I identified four species from the gut pools, which were shared with species of *Macrobrachium* (kribbishes) and atyid shrimps, and aquatic insects. The tropical peripheral-freshwater species that included the common mountain mullet (*Agonostomus monticola*) (Figure 13), spinycheek sleeper, and sirajo goby (*Sicydium plumieri*) occurred in fresh to low salinity waters in the gut pools, where they were joined by the catadromous American eel (Tables 9-11). All have wide distributions throughout the Caribbean, some species even having populations in Texas and Florida (Loftus et al. 1984). These species require unimpeded access between saltwater and freshwater habitats to complete their life cycles. Most individuals, with the exception of the spinycheek sleeper, and the mountain mullet in Living Gut (GP-01-W), were juveniles or sub-adults (Table 11). During my visits, the mountain mullet responded to seasonal variation in flow in the guts brought on by a December 2001 rain event by having a strong year class of mountain mullet move into Fish Bay Gut. That group of fish dominated the gut pools in numbers, persisted, and grew in size through my final visit in March 2003. However, their numbers were much lower than in May 2002 because the pool sizes had shrunk and there had been no further connection with the sea. Rainfall to maintain these pools appears to be critical to the survival of the fishes. For example, at the Petroglyph pools in Living Gut (GP-01-W), the small population of adult mountain mullet that had long inhabited those pools appeared to have been lost, perhaps to poor water quality during the drought of 2002. I recorded more than eight large mullet there in October 2001 and May 2002, but they were absent from these isolated pools on the two subsequent trips, when I saw and collected only shrimp and aquatic insects.

Physical-chemical conditions in Living and Fish Bay guts were less variable compared with the coastal ponds. Water temperatures were cooler, and changed little by season, normally hovering around 25-26^{0}C. Dissolved oxygen concentrations tended to be lower than in most coastal ponds, probably because of shading and organic material in the pools. Levels were higher in December (62%-supersaturation – Table 6), and lower in the warm, low waters of March (10.5-58% - Table 7). Values for pH ranged from 7.2-8.5 in December but rose above 10 in March.

Historical accounts of St. John indicate that at least several of these guts were flowing streams of freshwater that supported Amerindian inhabitants and early European settlements (Hatch 1972, Dammann and Nellis 1992). McGuire, in Hatch (1972), described Living Gut as a "small, sparkling brook, over a mile long draining a ravine …, forming a cascade and pool at the southern foot of Doubloon Hill." Another early account (1870), by the U. S. Consul, of Living Gut and the Petroglyph pools (Low and Valls 1985) stated that "it is a rocky dell upon the side of the mountain containing a waterfall, below which are pools filled with the crystal waters of this mountain rivulet and containing a beautiful little fish much resembling our brook trout." This is an obvious and early reference to the mountain mullet, which is the Caribbean's ecological analogue of the brook trout (*Salvelinus fontinalis*) from temperate North America. The account demonstrates the long-term residence of this species in this gut, which is only possible if the gut connects to the sea to allow in-migration of the post-larva. From these historical accounts, it is likely that populations of fishes in freshwater on St. John were larger and more widespread than recently.

Inland ponds: I identified 14 inland ponds from maps, but two of those did not exist. Nine ponds had no fishes, five within VIIS and four outside, because they were dry or isolated. I was also unable to sample several outside the park because they were on private property. One of these was a dammed pool within Carolina Gut (IP-02-E(1)), which I was told had been stocked by the owner with tilapia. An inland pond was the only location in VIIS in which I recorded a non-native species, Mozambique tilapia (*Oreochromis mossambicus*) (IP-01-W). However, guppies (*Poecilia reticulata*) are moved about on the island to kill mosquito larvae, mainly in ornamental ponds on private property (Rafe Boulon, pers. comm.). Guppies had been established in the cistern at Katherineberg (IP-05-W), but the site dried, eliminating the population. No guppies were found outside of ornamental ponds on my visits. A poeciliid was also reported from the artificial pond at Concordia several years ago (Douglas Smith, pers. comm.), but the periodic drying of this pond had extirpated them before this study began.

I identified only six species in this habitat, including the tilapia (Table 9). Several were marine invaders like the two snappers and the white mullet. Most inland ponds were freshwater or nearly so. The exception was the system at Caneel Bay Plantation, discussed in Methods. An interesting record there was the school of sub-adult mountain mullet at 47-49 PSU (Tables 6, 11), the highest recorded salinity for this peripheral-freshwater species. Tarpon were seen on two trips in the isolated artificial pond west of Fish Bay Gut (IP-06-W), into which they were either introduced or had become trapped.

Summary

Habitats: All inland habitats were fairly shallow. Inland ponds, particularly those constructed by man, were the deepest aquatic habitats on the island, but even these were less than two to three meters deep (Table 8). Freshwater habitats were rare on St. John, mainly represented by gut pools and constructed ponds. High salinities and lack of access combined to exclude fishes from habitats. The highest species richness of fishes was found in ponds that were mesohaline to slightly hypersaline, particularly if they were connected to the sea by an inlet or had low berms. The presence of red-mangrove stands may be used to indicate the presence of fishes if the site is not permanently isolated.

I asked several questions about habitat characteristics on St. John regarding the potential for those ponds to contain fishes. These factors should also apply to other islands in this area of the eastern Caribbean. Can hypersaline ponds have stands of red mangrove? - not usually, but in the few cases that did (CP09W, CP-13E, CP-14-E, CP-18-E), those ponds were only moderately or episodically hypersaline. Do all isolated ponds become hypersaline? Most isolated coastal ponds do, with exceptions like CP-12-W and CP-11-W, which received most of their water from freshwater runoff. Are all isolated ponds fishless? Most were, but it depends on the degree of isolation.

Perennially dry guts were fishless, coastal ponds with low berms might have fish, but those with high berms did not, and inland ponds usually had fish only if they had been introduced.

Fishes: I identified a total of 35 species (including the echeneid) in this inventory, with five additional taxa for which I had sight records but could not positively identify to species (Table 9). The presence of 22 families showed the lack of dominance by any single family in inland waters. Thirty-three species used coastal ponds, four were found in gut pools, and six in inland ponds. Coastal ponds shared two and one species with gut and inland ponds, respectively (Table 9). Gut pools and inland ponds shared only one species, the mountain mullet. Twenty-four species were found within the boundaries of VIIS, but the remaining 11 from extra-park waters should be considered as Hypothetical.

These collections provided the first island records for several fishes, including the mangrove rivulus (*Rivulus marmoratus*), swordspine snook (*Centropomus ensiferus*), fat sleeper *Dormitator maculatus*), emerald goby (*Erotelis smaragdus*), and sirajo goby (*Sicydium plumieri*). Most species belonged to marine-derived families, with the exception of the tilapiine cichlid and the rivulid killifish. The majority of inland species were small-sized species (Table 11) or juveniles of larger species such as tarpon, white mullet, or common snook. A number of species were confined to one habitat. For example, the sirajo goby occurred only in a few pools in Fish Bay Gut, and most of the marine invaders occurred only in coastal ponds. As in Florida, mangrove Rivulus was usually the only species of fish where it occurred. It is able to utilize microhabitats with conditions that are intolerable to other fishes, including crab burrows and hypoxic mangrove waters with high hydrogen sulfide levels (Davis et al. 1990). In addition, one of the mangrove rivulus specimens (CP-22-E) was the first record of a male from the eastern Caribbean (S. Taylor, pers. comm.), an unusual find for this predominately hermaphroditic fish. The record of mountain mullet (*Agonostomus monticola*) from 47-49 PSU water in Caneel Bay Plantation (IP-01-W(2)) is the highest salinity record for this species of which I am aware. It was also unusual to find the two snapper species, tilapia, and white mullet thriving in such hypersaline water there.

Mountain mullet, spinycheek sleeper, and American eel were the most widespread species in freshwater and oligohaline habitats on St. John. Mangrove rivulus, yellowfin mojarra, and tarpon were widespread in mangrove habitats. In higher salinity waters, yellowfin mojarra, white mullet, and the two snappers were common. The yellowfin mojarra appeared to recruit into inland waters in autumn (Table 11), based on size frequencies. Large numbers of small white mullet were also collected in December. Mountain mullet recruited into the gut at times of heavy rains that connected the gut to the sea. With the exception of the tropical peripheral-freshwater species (three species), most fishes appeared to utilize the inland waters of St. John as nursery areas.

Several authors have noted the paucity of freshwater fishes on islands of the eastern Caribbean, including Puerto Rico, the Virgin Islands, and the Lesser Antilles. Only five species have been recorded for the Lesser Antilles (Lee et al. 1983), including the mangrove rivulus, a marine invader in a secondary freshwater family. There is a reduction in freshwater species from west to east in the Greater Antilles, with Cuba being richer in species (Vergara 1992) than Hispaniola, which in turn is much richer than Puerto Rico (Miller 1982). In fact, the only native freshwater species recorded from Puerto Rico (*Poecilia vivipara*) is a dubious record (Erdman 1972, Miller 1982). Puerto Rico has the same inland species that I recorded from St. John, and many more (Erdman 1972) because of its size and habitat diversity. However, like St. John, its hypersaline salt ponds are normally fishless. This is an example of vicariance biogeography in that hypersaline-tolerant species of pupfishes (*Cyprinodon* spp), which inhabit those habitats farther west on the islands and mainland, have not been able to reach beyond Hispaniola (Miller 1982, Lee et al. 1983). St. Croix, south of St. John, also has all of the species I recorded from St. John, but has additional tropical peripheral-freshwater species such as the opossum pipefish (*Microphis brachyurus*), the river goby (*Awaous banana*), and the bigmouth sleeper (*Gobiomorus dormitor*) (Clavijo et al. 1980, Seaman 1989). It is possible that some of those may be taken on St. John with further sampling in the guts under wetter conditions, but the fact is that St. Croix has more potential habitat for those species. In addition, St. Croix also has more records for marine invaders in mangrove habitats than St. John (Clavijo et al. 1980), again a case of a larger island with more available habitat. The inland fish inventory of St. John produced the richness and species composition one would expect to find on an island of its size, habitat availability, and geographic position.

Topics of Concern

Introduced fishes are problematic where they occur. Fortunately, there are only one or two species that occur on the island, and these are relatively isolated on private lands. However, those species have presented problems by changing the character of the aquatic systems where they have escaped into natural areas. Both the guppy and Mozambique tilapia are widespread in freshwater and mangrove habitats on Puerto Rico (Erdman 1972, personal observation). Although suitable habitats are less available on St. John, either species introduced into small gut pools would likely survive and affect the native fishes in those limited habitats. Efforts should be made to discourage the use of those species on the island and to eliminate them when possible. To control mosquito larvae in isolated ponds, it would be better to use mountain mullet juveniles that are quite tolerant of pond or pool conditions.

Several guts with their upper reaches in VIIS have the lower parts of the drainage basins on private land. Because the tropical peripheral-freshwater fishes and the shrimps that inhabit the guts must ascend the channels from the sea as post-larvae or juveniles, any impediment to access could affect the populations of those species in park waters. As an example, I spoke to the owner of the property at the mouth of Fish Bay Gut in May 2002. He said that he had built a dam across the mouth of the gut to form a pool in which he had stocked blackfin sharks and tarpon for angling. Although I did not see the dam, this sort of structure could impede by fish and shrimp larvae. If possible, physical and water-quality barriers in the guts should be prevented to enable fish populations in the park to persist.

One finding of this study was that openings into salt ponds reduced the salinity and enabled fishes to access that habitat. In fact the greatest species richness occurred in embayments that had tidal outlets. The channel connecting Chocolate Hole Pond to the bay was deliberately widened and deepened between my October 2001 and May 2002 visits. This action seemed to result in more fishes moving between the pond and the bay, which may have been the reason for the dredging. This modification, although an enhancement for fish populations, ignores the value of salt ponds for other wildlife and for the halophilic aquatic organisms that have no other habitat.

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Figure Legends

Figure 1. Map of St. John, U.S. Virgin Islands, showing locations of all sites sampled during this study. Dashed line encloses the boundary of Virgin Islands National Park. Abbreviations for sites are: CP = coastal pond; IP = inland pond; GP = gut pool; E = eastern side of island; W = western side of island.

Figure 2. Coastal salt pond with no mangrove border and high berm separating it from the sea (Southside Pond, CP-10-E).

Figure 3. Coastal pond with inlet from sea, dead mangrove stand in middle, and mangrove border in December, 2002 (Yawzi Point Pond, CP-02-E(1)).

Figure 4. Coastal pond in mangrove stand behind beach berm at Trunk Bay, with a population of *Rivulus marmoratus* (CP-11-W).

Figure 5. Caneel Bay Plantation watercourse (IP-01-W(1)) running from the sewage polishing pond , collecting runoff from the desalinization plant, and emptying in to the Bay.

Figure 6. Artificial pond at Concordia (IP-01-E), wet in May 2002, but dry on subsequent visits. Feral donkeys and waterfowl in photo.

Figure 7. Seining for mountain mullet in Fish Bay Gut pool (GP-03-W(3)) in October 2001.

Figure 8. Collecting fishes with net in Fish Bay Gut pool in December 2002 (GP-03-W (5)).

Figure 9. Measuring environmental parameters with water-quality meter at Reef Bay Pond in March 2003 (CP-17-E).

Figure 10. Lemon shark (*Negaprion brevirostris*) taken by gill net at CP-02-E(1) in March 2003.

Figure 11. American eel (*Anguilla rostrata*) trapped in Fish Bay Gut (GP-03-W(1))in May 2002.

Figure 12. Spinycheek sleeper (*Eleotris perniger*) trapped in Fish Bay Gut (GP-03-W(1)) in May 2002.

Figure 13. Mountain mullet (*Agonostomus monticola*) captured by seine in Fish Bay Gut (GP-03-W(3)) in October 2001.

Table 1. Mean monthly and total annual rainfall amounts (mm) from Cruz Bay, St. John, U. S. Virgin Islands from 1971 to 1985.

Month	Rainfall	Year	Rainfall
January	58.42	1971	1106.17
February	54.10	1972	982.47
March	47.50	1973	931.93
April	95.25	1974	1379.22
May	123.44	1975	970.03
June	67.31	1976	935.99
July	77.98	1977	1206.25
August	119.13	1978	1442.47
September	161.54	1979	1878.58
October	149.35	1980	992.38
November	160.53	1981	1598.42
December	98.81	1982	1230.38
		1983	1306.58
		1984	1225.80
		1985	944.12

Table 2. A. Monthly mean streamflow (Cubic feet per second) in Guinea Gut, Bethany, St. John, U. S. Virgin Islands; B. Monthly mean streamflow (Cubic feet per second) in Lameshur Bay Gut (USGS data).

A. YEAR	Monthly mean streamflow, in ft^3/s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1984										.003	2.52	.073
1985	.030	.014	.009	.008	.013	.003	.010	.010	.010	.23	.092	.013
1986	.009	.001	.000	.17	.89	.020	.021	.020	.039	.043	.14	.000
1987	.004	.011	.005	.002	.008	.031	.000	.004	.001	.010	.66	.020
1988	.013	.008	.005	.008	.003	.000	.001	.026	.63	.056	.043	.11
1989	.044	.017	.008	.008	.009	.009	.002	.009	2.35	.10	.047	.006
1990	.027	.002	.008	.021	.026	.010	.038	.025	.015	.16	.013	.011
1991	.007	.000	.000	.002	.007	.000	.000	.000	.000	.000	.000	.000
1992	.000	.000	.001	.000	.32	.014	.010	.006	.006	.000	.006	.025
1993	.004	.002	.001	.001	.001	.025	.000	.000	.003	.000	.23	.072
1994	.000	.000	.000	.002	.000	.000	.000	.000	.000	.000	.000	.000
1995	.000	.000	.000	.000	.000	.000	.005	.015	.98	.030	.019	.015
1996	.035	.019	.023	.043	.011	.005	.041	.019	.50	.033	.87	.057
1997	.052	.033	.009	.010	.020	.012	.010	.002	.010	.42	.023	.017
1998	.013	.007	.011	.025	.011	.011	.014	.003	.47	.31	.36	.50
1999	.075	.062	.035	.048	.044	.036	.016	.011	.008	.028	1.40	.57
2000	.12	.12	.051	.020	.022	.021	.019	.014	.013			
Mean of monthly streamflows	.027	.019	.010	.023	.087	.012	.012	.010	.31	.089	.40	.093
B. YEAR	Monthly mean streamflow, in ft^3/s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992									.000	.000	.13	.034
1993	.005	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
1994	.000	.000	.000	.000	.000	.000	.000	.000	.000			
Mean of monthly streamflows	.003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.065	.017

Table 3. List of sampling locations on St. John, U.S. Virgin Islands.

Site	Pond Type	Island Side	In VIIS	Name/Area	W	N
CP-01-E	Coast	East	Y	Europa Pond	-64.732350	18.319533
CP-02-E(1)	Coast	East	Y	Yawzi Point Pond (Inlet)	-64.724517	18.320450
CP-02-E(2)	Coast	East	Y	Yawzi Point Pond (at Rd.)	-64.724500	18.320467
CP-03-E	Coast	East	Y	E of Great Lameshur	-64.720000	18.318433
CP-04-E	Coast	East	Y	Mandal Pond	-64.712800	18.314183
CP-05-E(1)	Coast	East	Y	Salt Pond	-64.704867	18.307833
CP-05-E(2)	Coast	East	Y	Little Salt pond (SW)	-64.705833	18.307217
CP-06-E	Coast	East	N	Across from Calvary Church	-64.699583	18.322400
CP-07-E	Coast	East	N	N of Friis Bay	-64.700817	18.327433
CP-08-E	Coast	East	Y	Harbor Point Pond	-64.705167	18.356667
CP-09-E	Coast	East	Y	Turner Point Pond	Not Sampled	
CP-10-E	Coast	East	N	Southside Pond	-64.674617	18.332783
CP-11-E	Coast	East	N	Privateer Bay	Not Sampled	
CP-12-E	Coast	East	N	Newfound Bay	Not Sampled	
CP-13-E	Coast	East	Y	Brown Bay Pond	-64.705883	18.360300
CP-14-E	Coast	East	Y	Leinster Bay	-64.720667	18.362317
CP-15-E	Coast	East	Y	Fredriksdal Mangroves	-64.735167	18.363300
CP-16-E	Coast	East	Y	N Shore - Please	Not Sampled	
CP-17-E	Coast	East	Y	Reef Bay Mangroves	-64.745117	18.322167
CP-18-E	Coast	East	Y	Mangroves S of Salt Pond	-64.701767	18.305883
CP-19-E	Coast	East	Y	Kiddel Bay	-64.712417	18.309617
CP-20-E	Coast	East	Y	Fortsberg, E of Harbor Pt	Not Sampled	
CP-21-E-(1)	Coast	East	N	East Base, Coral Bay(E)	-64.708483	18.347200
CP-21-E-(2)	Coast	East	N	East Base, Coral Bay (W)	-64.708483	18.347217
CP-22-E	Coast	East	N	Coral Bay Mangroves	-64.716300	18.345533
CP-23-E	Coast	East	Y	Mangroves near Annaberg	-64.733050	18.363300
GP-01-E	Gut	East	Y	Cob Gut	-64.712450	18.314750
IP-01-E	Inland	East	N	Concordia Ag Pond	-64.706917	18.312800
IP-02-E-(1)	Inland	East	N	Carolina (up gut)	-64.754400	18.347833
IP-02-E-(2)	Inland	East	N	King Hill Gut south branch	-64.723800	18.341583
IP-03-E	Inland	East	Y	Zootenvaal Pond	-64.704167	18.354000
IP-04-E	Inland	East	Y	Access through Elk Bay	-64.683333	18.350000
IP-05-E	Inland	East	Y	W of Haulover	-64.681433	18.346767
IP-06-E	Inland	East	N	East End Pond	-64.673767	18.341800
CP-01-W	Coast	West	N	E of Chocolate Hole (Hart Bay)	-64.780567	18.318317
CP-02-W	Coast	West	N	E. of Chocolate Hole Shore	-64.784883	18.315717
CP-03-W	Coast	West	N	Chocolate Hole	-64.784883	18.318017
CP-04-W	Coast	West	N	Pond , W. of Chocolate Hole	Not Sampled	
CP-05-W	Coast	West	N	Enighed Pond	Not Sampled	
CP-06-W	Coast	West	N	Frank Bay (Gallow's Point)	Not Sampled	
CP-07-W	Coast	West	Y	Turtle Point Pond	-64.786000	18.351667
CP-08-W(1)	Coast	West	Y	Maho Bay Mangrove Pond	-64.744517	18.357650
CP-08-W(2)	Coast	West	Y	Maho Bay Mangrove Pond	-64.744533	18.357650
CP-09-W	Coast	West	Y	Francis Bay Mangroves	-64.742933	18.364983
CP-10-W	Coast	West	N	Guinea Gut Terminus (Westin)	-64.789167	18.321900

Site	Pond Type	Island Side	In VIIS	Name/Area	W	N
CP-11-W	Coast	West	Y	Trunk Bay Mangrove Pond	-64.769383	18.351400
CP-12-W	Coast	West	Y	Cinnamon Bay Pool	-64.754117	18.354583
CP-13-W	Coast	West	N	Fish Bay Mangrove	-64.761200	18.321833
GP-01-W-(1)	Gut	West	Y	Petroglyph Pool-Upper	-64.743550	18.331600
GP-01-W-(2)	Gut	West	Y	Petroglyph Pool-Lower	-64.743550	18.331617
GP-02-W	Gut	West	Y	"Mosquito Bridge" Gut	-64.758467	18.323300
GP-03-W(1)	Gut	West	N	Fish Bay Gut-Pool 1	-64.764400	18.329300
GP-03-W(2)	Gut	West	N	Fish Bay Gut-Pool 2	-64.764417	18.329333
GP-03-W(3)	Gut	West	N	Fish Bay Gut-Pool 3	64.764333	18.329367
GP-03-W(4)	Gut	West	N	Fish Bay Gut-Pool 4	-64.764500	18.329467
GP-03-W(5)	Gut	West	N	Fish Bay Gut-Pool 5	-64.764500	18.329733
GP-03-W(6)	Gut	West	N	Fish Bay Gut-Pool 6	-64.764567	18.329733
GP-03-W(7)	Gut	West	N	Fish Bay Gut-Pool 7	-64.764560	18.329867
GP-04-W	Gut	West	N	Guinea Gut	-64.789167	18.323333
GP-05-W	Gut	West	Y	Maho Gut Pool	-64.739183	18.356617
GP-06-W	Gut	West	Y	Source of Battery Gut (Rt. 10)	-64.761200	18.344383
IP-01-W(1)	Inland	West	Y	Caneel Bay Run	-64.785833	18.342667
IP-01-W(2)	Inland	West	Y	Caneel Bay Polishing Pond	-64.785833	18.342633
IP-02-W	Inland	West	Y	Susannaberg Pond	-64.760833	18.344600
IP-03-W	Inland	West	Y	Pond at Katherineberg	-64.761467	18.343433
IP-04-W	Inland	West	Y	S.Rt. 10 Ponds	Not Sampled	
IP-05-W	Inland	West	Y	Cistern at Katherineberg Ruins	-64.761183	18.344250
IP-06-W	Inland	West	Y	Ag. Pond at East Fish Bay Gut	-64.758583	18.322067

Table 4. Sampling data by location for St. John, U.S. Virgin Islands, October 2001.

Site	In VIIS	Name/Area	N	W	Date	Time	Salinity (PSU)
CP-01-E	Y	Europa Pond	18.319533	-64.732350			
CP-02-E(1)	Y	Yawzi Point Pond	18.318245	-64.722227	20-Oct-01	11:00	38
CP-02-E(2)	Y	Yawzi Point Pond	18.320467	-64.724500	20-Oct-01	13:30	38
CP-03-E	Y	E of Great Lameshur	18.318433	-64.720000			
CP-04-E	Y	Mandal Pond	18.314183	-64.712800			
CP-05-E(1)	Y	Salt Pond	18.307833	-64.704867	23-Oct-01	12:30	>100
CP-05-E(2)	Y	Little Salt pond (SW)	18.307217	-64.705833	23-Oct-01	13:30	37
CP-06-E	N	Across from Calvary Church	18.322400	-64.699583			
CP-07-E	N	N of Friis Bay	18.327433	-64.700817			
CP-08-E	Y	Harbor Point Pond	18.342667	-64.707167			
CP-09-E	Y	Turner Point Pond	Not sampled				
CP-10-E	N	Southside Pond	18.332783	-64.674617			
CP-11-E	N	Privateer Bay	Not sampled				
CP-12-E	N	Newfound Bay	Not sampled				
CP-13-E	Y	Brown Bay Pond	18.360300	-64.705883			
CP-14-E	Y	Leinster Bay	18.362317	-64.720667			
CP-15-E	Y	Fredriksdal Mangroves	18.363300	-64.735167			
CP-16-E	Y	N Shore - Please	Not sampled				
CP-17-E	Y	Reef Bay Mangroves	18.322167	-64.745117			
CP-18-E	Y	Mangroves S of Salt Pond	18.305883	-64.701767			
CP-19-E	Y	Kiddel Bay	18.309617	-64.712417			
CP-20-E	Y	Fortsberg, E of Harbor Pt	Not sampled				
CP-21-E-(1)	N	East Base, Coral Bay(E)	18.347200	-64.708483			
CP-21-E-(2)	N	East Base, Coral Bay (W)	18.347217	-64.708483			
CP-22-E	N	Coral Bay Mangroves	18.345533	-64.716300			
CP-23-E	Y	Mangroves near Annaberg	18.363300	-64.733050			
GP-01-E	Y	Cob Gut	18.314750	-64.712450			
IP-01-E	N	Concordia Ag Pond	18.312800	-64.706917			
IP-02-E-(1)	N	Carolina (up gut)	18.346666	-64.724706			
IP-02-E-(2)	N	King Hill Gut south branch	18.343583	-64.723800			
IP-03-E	Y	Zootenvaal Pond	18.354000	-64.704167			
IP-04-E	Y	Access through Elk Bay	18.348459	-64.683647			
IP-05-E	Y	W of Haulover	18.346767	-64.681433			
IP-06-E	N	East End Pond	18.341800	-64.673767			
CP-01-W	N	E of Chocolate Hole	18.318317	-64.780567			
CP-02-W	N	E of Chocolate Hole Shore	18.315414	-64.784281			
CP-03-W	N	Chocolate Hole	18.318017	-64.784883	23-Oct-01	9:30	36
CP-04-W	N	Pond, W of Chocolate Hole	Not sampled				
CP-05-W	N	Enighed Pond	Not sampled				

Site	In VIIS	Name/Area	N	W	Date	Time

CP-06-W	N	Frank Bay (Gallow's Point)	Not sampled				
CP-07-W	Y	Turtle Point Pond	18.348986	-64.786418			
CP-08-W(1)	Y	Maho Bay Mangrove Pond	18.357650	-64.744517			
CP-08-W(2)	Y	Maho Bay Mangrove Pond	18.357650	-64.744533			
CP-09-W	Y	Francis Bay Mangroves	18.364983	-64.742933			
CP-10-W	N	Guinea Gut at Westin	18.323295	-64.788109			
CP-11-W	Y	Trunk Bay Mangrove Pond	18.351400	-64.769383			
CP-12-W	Y	Cinnamon Bay Pool	18.354583	-64.754117			
CP-13-W	N	Fish Bay Mangrove	18.321833	-64.761200			
GP-01-W-(1)	Y	Petroglyph Pool-Upper	18.331600	-64.743550	22-Oct-01	10:00	0
GP-01-W-(2)	Y	Petroglyph Pool-Lower	18.331617	-64.743550	22-Oct-01	10:30	0
GP-02-W	Y	"Mosquito Bridge" Gut	18.323300	-64.758467			
GP-03-W(1)	N	Fish Bay Gut-Pool 1	18.329300	-64.764400	21-Oct-01	9:30	0
GP-03-W(2)	N	Fish Bay Gut-Pool 2	18.329451	-64.764492	21-Oct-01	10:30	0
GP-03-W(3)	N	Fish Bay Gut-Pool 3	18.329367	-64.764333	21-Oct-01	11:00	0
GP-03-W(4)	N	Fish Bay Gut-Pool 4	18.329570	-64.764542	21-Oct-01	11:45	0
GP-03-W(5)	N	Fish Bay Gut-Pool 5	18.329680	-64.764620	21-Oct-01	13:00	0
GP-03-W(6)	N	Fish Bay Gut-Pool 6	18.329667	-64.764567	21-Oct-01	13:25	0
GP-03-W(7)	Y	Fish Bay Gut-Pool 7	18.329867	-64.764560	21-Oct-01	14:30	0
GP-04-W	N	Guinea Gut	18.325361	-64.784669			
GP-05-W	Y	Maho Gut Pool	18.356617	-64.739183			
GP-06-W	Y	Source of Battery Gut	18.343038	-64.762776			
IP-01-W(1)	Y	Caneel Bay Run	18.342667	-64.785833			
IP-01-W(2)	Y	Caneel Bay Polishing Pond	18.342633	-64.785833			
IP-02-W	Y	Susannaberg Pond	18.341858	-64.770726			
IP-03-W	Y	Pond at Katherineberg	18.343433	-64.761467			
IP-04-W	Y	S.Rt. 10 Ponds	Not sampled				
IP-05-W	Y	Cistern at Katherineberg	18.344416	-64.761238			
IP-06-W	Y	Ag. Pond by E. Fish Bay Gut	18.322067	-64.758583			

Table 5. Sampling data by location for St. John, U.S. Virgin Islands, May 2002.

Site	N	W	May Date 1	Salinity (PSU)	Temp. (^oC)	Time	Method
CP-01-E	18.319533	-64.732350	16-May-02	>100	40	11:41	Visual
CP-02-E(1)	18.318245	-64.722227	16-17 May 02	43	32	12:44	Traps, Dip net, Angling
CP-02-E(2)	18.320467	-64.724500	16-17 May 02			12:58	Visual
CP-03-E	18.318433	-64.720000	16-May-02	76	35	14:42	Visual, Dip net
CP-04-E	18.314183	-64.712800	16-May-02	68	32	15:45	Visual
CP-05-E(1)	18.307833	-64.704867					
CP-05-E(2)	18.307217	-64.705833					
CP-06-E	18.322400	-64.699583	17-May-02			14:02	Visual
CP-07-E	18.327433	-64.700817	17-May-02			14:10	Visual
CP-08-E	18.342667	-64.707167					
CP-09-E	Not sampled						
CP-10-E	18.332783	-64.674617					
CP-11-E	Not sampled						
CP-12-E	Not sampled						
CP-13-E	18.360300	-64.705883					
CP-14-E	18.362317	-64.720667	18-May-02			15:40	Visual
CP-15-E	18.363300	-64.735167	18-May-02			15:45	Visual
CP-16-E	Not sampled						
CP-17-E	18.322167	-64.745117					
CP-18-E	18.305883	-64.701767					
CP-19-E	18.309617	-64.712417					
CP-20-E	Not sampled						
CP-21-E-(1)	18.347200	-64.708483					
CP-21-E-(2)	18.347217	-64.708483					
CP-22-E	18.345533	-64.716300	17-May-02			14:20	
CP-23-E	18.363300	-64.733050					
GP-01-E	18.314750	-64.712450	16-May-02			8:05	Visual
IP-01-E	18.312800	-64.706917	16-May-02	0		15:45	Traps, Dipnet
IP-02-E-(1)	18.346666	-64.724706	17-May-02			14:40	
IP-02-E-(2)	18.343583	-64.723800					
IP-03-E	18.354000	-64.704167	17-May-02				
IP-04-E	18.348459	-64.683647	17-May-02			15:00	Visual
IP-05-E	18.346767	-64.681433	17-May-02			15:20	Visual
IP-06-E	18.341800	-64.673767	17-May-02			15:40	Visual
CP-01-W	18.318317	-64.780567	19-May-02	60		11:38	Visual, traps
CP-02-W	18.315414	-64.784281	18-May-02			9:50	Visual
CP-03-W	18.318017	-64.784883	18-20,22 May	40		8:02	Visual, Traps, Seine
CP-04-W	Not sampled		18-May-02	>100		9:38	Visual
CP-05-W	Not sampled		18-May-02			12:08	Visual
CP-06-W	Not sampled		18-May-02	88		12:29	Visual
CP-07-W	18.348986	-64.786418	20-May-02			13:48	Visual
CP-08-W(1)	18.357650	-64.744517	21-22 May 02	5	31	14:20	Visual, traps,
Site	**N**	**W**	**Date**	**Salinity (PSU)**	**Temp. (^oC)**	**Time**	**Method**

CP-08-W(2)	18.357650	-64.744533	21-22 May 02	5	31	14:40	Visual, traps
CP-09-W	18.364983	-64.742933	18-May-02			15:43	Visual
CP-10-W	18.323295	-64.788109	22-May-02	44	29	8:52	Visual
CP-11-W	18.351400	-64.769383	21-May-02			11:40	Visual
CP-12-W	18.354583	-64.754117	21-May-02			12:40	Visual
CP-13-W	18.321833	-64.761200					
GP-01-W-(1)	18.331600	-64.743550	16-17 May 02	2	28	10:05	Visual, Angling,
GP-01-W-(2)	18.331617	-64.743550	16-17 May 02	2	28	10:15	Visual, Angling,
GP-02-W	18.323300	-64.758467	20-May-02			13:45	Visual
GP-03-W(1)	18.329300	-64.764400	19-21 May 02	0		12:08	Visual, traps, Dip Net, Snorkeling
GP-03-W(2)	18.329451	-64.764492	19-21 May 02	0		12:28	Visual, traps, Dip Net, Snorkeling
GP-03-W(3)	18.329367	-64.764333	19-21 May 02	0		12:50	Visual, traps, Dip Net, Snorkeling
GP-03-W(4)	18.329570	-64.764542	19-21 May 02	0		13:20	Visual, traps, Dip Net, Snorkeling
GP-03-W(5)	18.329680	-64.764620	19-21 May 02	0		14:05	Visual, traps, Dip Net, Snorkeling
GP-03-W(6)	18.329667	-64.764567	19-21 May 02	0		14:42	Visual, traps, Dip Net, Snorkeling
GP-03-W(7)	18.329867	-64.764560	19-21 May 02	0		14:50	Visual
GP-04-W	18.325361	-64.784669	22-May-02			8:00	Visual
GP-05-W	18.356617	-64.739183					
GP-06-W	18.343038	-64.762776	20-May-02			14:20	Visual
IP-01-W(1)	18.342667	-64.785833	20-22 May 02	47	31	9:25	Visual, Cast Net
IP-01-W(2)	18.342633	-64.785833	20-22 May 02	2	30	11:30	Traps. Dip net
IP-02-W	18.341858	-64.770726	20-May-02				
IP-03-W	18.343433	-64.761467	20-May-02			14:15	Visual
IP-04-W	Not sampled		20-May-02			15:25	Visual
IP-05-W	18.344416	-64.761238	20-May-02	0		14:25	Visual
IP-06-W	18.322067	-64.758583	20-May-02	0		12:25	Visual, Angling

Table 6. Sampling data by location for St. John, U.S. Virgin Islands, December 2002.

Site	N	W	Date	Salinity (PSU)	Temp. (^{o}C)	Specific Cond. (mS/cm)	DO (%)	DO (mg/l)	pH	Time	Method
CP-01-E	18.319533	-64.732350									
CP-02-E(1)	18.318245	-64.722227	7-Dec-02	35	27.6	52.17	114.5	7.46	8.17	10:31	Traps, Dip net, Angling
CP-02-E(2)	18.320467	-64.724500	8-Dec-02	37	31.1	54.65	156	9.49	7.99	11:41	Traps, Dip net, Angling
CP-03-E	18.318433	-64.720000	7-Dec-02							11:10	None
CP-04-E	18.314183	-64.712800	7-Dec-02	>100	33.5	191.8	92	2.7	7.45	12:44	None
CP-05-E(1)	18.307833	-64.704867	8-Dec-02	>100	29.7	200.8	106	3.04	7.73	17:32	None
CP-05-E(2)	18.307217	-64.705833									
CP-06-E	18.322400	-64.699583	7-Dec-02	70							Visual
CP-07-E	18.327433	-64.700817									
CP-08-E	18.342667	-64.707167	8-Dec-02	45							Visual
CP-09-E	Not sampled										
CP-10-E	18.332783	-64.674617	7-Dec-02	>100	29.8	131.9	196.2	8.3	8.1	14:42	None
CP-11-E	Not sampled										
CP-12-E	Not sampled										
CP-13-E	18.360300	-64.705883									
CP-14-E	18.362317	-64.720667	10-Dec-02	61	29.2	75.8	134.5	7.86	8.96	14:45	Visual
CP-15-E	18.363300	-64.735167	10-Dec-02								Visual
CP-16-E	Not sampled										
CP-17-E	18.322167	-64.745117	9-Dec-02	42	27.9	63.71	14	0.8	7.35	12:19	Traps
CP-18-E	18.305883	-64.701767	8-Dec-02	42	29.6	56.68	91.3	5.67	7.83	16:59	Visual, traps
CP-19-E	18.309617	-64.712417	7-Dec-02	>100	26.9	168.4	99.6	3.63	7.74	9:32	Visual
CP-20-E	Not sampled		8-Dec-02								
CP-21-E-(1)	18.347200	-64.708483	8-Dec-02	45.5	28.6	63.75	212	12.98	8.66	10:15	Visual, traps
CP-21-E-(2)	18.347217	-64.708483	10-Dec-02	40							
CP-22-E	18.345533	-64.716300	8-Dec-02								Visual
CP-23-E	18.363300	-64.733050									

Site	N	W	Date	Salinity (PSU)	Temp. (^{o}C)	Specific Cond. (mS/cm)	DO (%)	DO (mg/l)	pH	Time	Method
GP-01-E	18.314750	-64.712450	7-Dec-02								Visual

Site	N	W	Date	Salinity (PSU)	Temp. (^oC)	Specific Cond. (mS/cm)	DO (%)	DO (mg/l)	pH	Time	Method
IP-01-E	18.312800	-64.706917	7-Dec-02								Visual
IP-02-E-(1)	18.346666	-64.724706	7-Dec-02								
IP-02-E-(2)	18.343583	-64.723800	7-Dec-02								Visual
IP-03-E	18.354000	-64.704167	7-Dec-02								
IP-04-E	18.348459	-64.683647	7-Dec-02								
IP-05-E	18.346767	-64.681433	7-Dec-02	43	30.1	60.84	109.8	6.6	7.97	15:33	Visual, traps
IP-06-E	18.341800	-64.673767									
CP-01-W	18.318317	-64.780567	11-Dec-02	>100							Visual
CP-02-W	18.315414	-64.784281	11-Dec-02								Visual
CP-03-W	18.318017	-64.784883	11-Dec-02	36	28.2	2.46	109.6	7.07	8.17	15:42	Gee-8 traps
CP-04-W	Not sampled										
CP-05-W	Not sampled										
CP-06-W	Not sampled										
CP-07-W	18.348986	-64.786418	12-Dec-02	49							Visual
CP-08-W(1)	18.357650	-64.744517	12-Dec-02	11	24.7	14.25	11.2	0.82	7.5	9:27	Visual, traps
CP-08-W(2)	18.357650	-64.744533	12-Dec-02	14	24.2	17.2	5.7	0.45	7.66	9:36	Visual, traps
CP-09-W	18.364983	-64.742933	10-Dec-02	>100	30.5	136.2	148.6	6.23	8.13	15:43	Visual
CP-10-W	18.323295	-64.788109	13-Dec-02	56	28.7	74.08	123	7.14	7.6	8:52	Traps, nets
CP-11-W	18.351400	-64.769383	11-Dec-02	4	25.2	4.808	14.2	1.15	7.66	13:43	Gee-8 traps
CP-12-W	18.354583	-64.754117	11-Dec-02	6	24.7	9.369	7.2	0.57	7.93	12:56	Gee-8 traps
CP-13-W	18.321833	-64.761200	13-Dec-02	45	26.8	58.97	145	9.3	8.38	10:54	Seine, Gee-8 traps
GP-01-W-(1)	18.331600	-64.743550	8-9 Dec 02	0	27.1	1.206	25.3	2	7.62	14:00	Visual, traps
GP-01-W-(2)	18.331617	-64.743550	8-9 Dec 02	0	26.9	1.02	36.5	2.96	7.54	14:03	Visual, traps
GP-02-W	18.323300	-64.758467									
GP-03-W(1)	18.329300	-64.764400	12-13 Dec 02	3.5	26.6	2.997	86.2	6.85	7.98	16:21	Visual, traps, snorkeling
GP-03-W(2)	18.329451	-64.764492	12-13 Dec 02	3.5	25.4	2.765	70.4	5.72	8.28	16:15	Visual, traps, snorkeling
GP-03-W(3)	18.329367	-64.764333	12-13 Dec 02	2.5	26.6	1.235	104.6	8.37	8.54	16:10	Visual, traps, snorkeling
GP-03-W(4)	18.329570	-64.764542	12-13 Dec 02	4	25.9	2.921	82.8	6.67	7.91	16:04	Visual, traps, snorkeling
GP-03-W(5)	18.329680	-64.764620	12-13 Dec 02	3	26.1	3.061	84.3	6.77	7.98	15:55	Visual, traps, snorkeling
GP-03-W(6)	18.329667	-64.764567	12-13 Dec 02	3	26.1	2.806	62.5	5.01	7.75	15:50	Visual, traps, snorkeling
GP-03-W(7)	18.329867	-64.764560	12-13 Dec 02								Visual, traps
GP-04-W	18.325361	-64.784669									

GP-05-W	18.356617	-64.739183	11-Dec-02	1.5	24.3	0.386	4.5	0.37	7.2	10:47	Gee-8 traps
GP-06-W	18.343038	-64.762776									
IP-01-W(1)	18.342667	-64.785833	11-12 Dec 02	49							
IP-01-W(2)	18.342633	-64.785833									
IP-02-W	18.341858	-64.770726									
IP-03-W	18.343433	-64.761467	11-Dec-02								
IP-04-W	Not sampled										
IP-05-W	18.344416	-64.761238	11-Dec-02								Visual
IP-06-W	18.322067	-64.758583									

Table 7. Sampling data at sites for St. John, U.S. Virgin Islands, March 2003. Specific conductance readings were unreliable.

Site	N	W	Date	Salinity (PSU)	Temp. (^oC)	DO %	DO (mg/l)	pH	Time	Method
CP-01-E	18.319533	-64.732350	23-Mar-03	>110	33.4	161.3	-	8.33	14:15	Visual
CP-02-E(1)	18.318245	-64.722227	23-24 Mar 03	37	32.2	72.1	0.77	7.71	13:15	Trap/Gill
CP-02-E(2)	18.320467	-64.724500	23-24 Mar 03	48	41.3	71	1.05	7.81	13:40	Traps
CP-03-E	18.318433	-64.720000	23-Mar-03							Visual
CP-04-E	18.314183	-64.712800	23-Mar-03							Visual
CP-05-E(1)	18.307833	-64.704867	23-Mar-03	>110	30.8	17.5	-	7.47	11:01	Visual/Net
CP-05-E(2)	18.307217	-64.705833	23-Mar-03	~ 110	30.7	115.6	-	8.7	10:58	Visual
CP-06-E	18.322400	-64.699583	23-Mar-03	105	32.4	280.3	-	9.13	9:32	Visual
CP-07-E	18.327433	-64.700817	23-Mar-03	>110	30.3	14	-	7.83	9:11	Visual
CP-08-E	18.342667	-64.707167								
CP-09-E	Not sampled									
CP-10-E	18.332783	-64.674617	22-Mar-03	92	31.5	91.4	-	8.2	1:40	Visual, Net
CP-11-E	Not sampled									
CP-12-E	Not sampled									
CP-13-E	18.360300	-64.705883	22-Mar-03	47	34.5	82	0.57	7.9	15:05	Visual
CP-14-E	18.362317	-64.720667								
CP-15-E	18.363300	-64.735167	26-Mar-03							Visual
CP-16-E	Not sampled									
CP-17-E	18.322167	-64.745117	24-25 Mar 03	40	32.6	149.4	1.53	8.49	11:01	Trap/Visual
CP-18-E	18.305883	-64.701767	23-Mar-03	47	29.4	43.3	0.16	7.87	10:34	Visual
CP-19-E	18.309617	-64.712417	23-Mar-03							Visual
CP-20-E	Not sampled									
CP-21-E-(1)	18.347200	-64.708483	22-23 Mar 03	47	35	201	1.35	8.57	10:00	Trap
CP-21-E-(2)	18.347217	-64.708483	22-23 Mar 03							Visual
CP-22-E	18.345533	-64.716300	23-24 Mar 03	40	26.8	39.7	0.43	7.5	15:24	Trap
CP-23-E	18.363300	-64.733050	27-28 Mar 03	8	25				14:20	Trap
GP-01-E	18.314750	-64.712450	23-Mar-03							Visual
IP-01-E	18.312800	-64.706917	23-Mar-03							Visual

Site	N	W	Date	Salinity (PSU)	Temp. (^oC)	DO %	DO (mg/l)	pH	Time	Method

Site	N	W	Date	Salinity (PSU)	Temp. (°C)	DO %	DO (mg/l)	pH	Time	Method
IP-02-E-(1)	18.346666	-64.724706	26-Mar-03							Visual
IP-02-E-(2)	18.343583	-64.723800	26-Mar-03							Visual
IP-03-E	18.354000	-64.704167								Visual
IP-04-E	18.348459	-64.683647	22-Mar-03							Visual
IP-05-E	18.346767	-64.681433	22-Mar-03							Visual
IP-06-E	18.341800	-64.673767	22-Mar-03							Visual
CP-01-W	18.318317	-64.780567	26-Mar-03							Visual
CP-02-W	18.315414	-64.784281	26-Mar-03	37	29.96	103	1.16	9.73	11:47	Sight
CP-03-W	18.318017	-64.784883	25-27 Mar 03	35.5	30	120.8	1.35	11.69	12:21	Traps/Gill Net
CP-04-W	Not sampled									
CP-05-W	Not sampled									
CP-06-W	Not sampled									
CP-07-W	18.348986	-64.786418								
CP-08-W(1)	18.357650	-64.744517	25-26 Mar 03	12.5	25.98	8.8	0.4	3.69	13:12	Traps
CP-08-W(2)	18.357650	-64.744533	25-26 Mar 03	14	25.92	6.4	0.29	4.95	14:11	Traps
CP-09-W	18.364983	-64.742933	27-Mar-03	33					15:00	Sight
CP-10-W	18.323295	-64.788109	28-Mar-03						9:00	Sight
CP-11-W	18.351400	-64.769383								
CP-12-W	18.354583	-64.754117	27-28 Mar 03	30					13:30	Trap
CP-13-W	18.321833	-64.761200	27-28 Mar 03	40	27.5	72.4	0.19	9.2	9:08	Trap
GP-01-W-(1)	18.331600	-64.743550	24-25 Mar 03	0-1	26.3	11.8	0.96	12	10:04	Trap
GP-01-W-(2)	18.331617	-64.743550	24-25 Mar 03	0-1	26.1	12.1	0.92	11		Trap
GP-02-W	18.323300	-64.758467	27-Mar-03							Sight
GP-03-W(1)	18.329300	-64.764400	26-27 Mar 03	3.5	25.6	16	1.23	10.9	9:49	Trap
GP-03-W(2)	18.329451	-64.764492	26-27 Mar 03	3.5	26	10.5	0.78	10.6	10:03	Trap
GP-03-W(3)	18.329367	-64.764333	26-27 Mar 03	0	26.3	29.7	2.36	12.7	10:09	Trap
GP-03-W(4)	18.329570	-64.764542	26-27 Mar 03	2	25.3	37.8	2.84	10.8	10:29	Trap
GP-03-W(5)	18.329680	-64.764620	26-27 Mar 03	3	26.5	57.8	4.27	10.7	10:35	Trap
GP-03-W(6)	18.329667	-64.764567	26-27 Mar 03	2.5	25.6	34.8	2.65	10.6	10:40	Trap
GP-03-W(7)	18.329867	-64.764560	26-27 Mar 03							Visual
GP-04-W	18.325361	-64.784669	26-Mar-03							

GP-05-W	18.356617	-64.739183	26-Mar-03								Visual
GP-06-W	18.343038	-64.762776									Visual
IP-01-W(1)	18.342667	-64.785833									
IP-01-W(2)	18.342633	-64.785833	26-Mar-03								
IP-02-W	18.341858	-64.770726									
IP-03-W	18.343433	-64.761467	26-Mar-03								Visual
IP-04-W	Not sampled										
IP-05-W	18.344416	-64.761238	26-Mar-03								Visual
IP-06-W	18.322067	-64.758583	23-Mar-03	2.5		27.8	95.1	7.32	7.91	8:43	Visual

Table 8. Site characteristics of sampling locations on St. John, U. S. Virgin Islands. Isolated refers to water bodies separated from other bodies by a significant land barrier. Hypersaline conditions refer to salinities above 35 PSU. *Rhizophora* refers to the presence of red mangroves on the pond border. A – Habitats within VIIS; B – Habitats outside VIIS.

A.

Site	In VIIS	N	W	Dry	Isolated	Salinity (PSU) 10/01	05/02	12/02	03/03	Hypersaline	*Rhizophora*	Depth (m) 10/01	05/02	12/02	03/03
CP-01-E	Y	18.319533	-64.732350	N	Y		>100		>110	Y	N		0.1-0.5		
CP-02-E(1)	Y	18.318245	-64.722227	N	N	38	43	35	37	Y	Y	0.5-1.0	0.5-1.0	0.5-1.0	0.5-1.0
CP-02-E(2)	Y	18.320467	-64.724500	N	N	38		37	48	Y	Y	0-0.1	0-0.1	0-0.1.0	0-0.1.0
CP-03-E	Y	18.318433	-64.720000	N	N		76			Y	N		0.1-0.25	0	0
CP-04-E	Y	18.314183	-64.712800	N	Y		68	>100		Y	N		0-0.2	0-0.1	
CP-05-E(1)	Y	18.307833	-64.704867	N	Y	>100		>100	>110	Y	N	0-0.25			
CP-05-E(2)	Y	18.307217	-64.705833	N	Y	37			~ 110	Y	N	0.1-0.3			
CP-07-W	Y	18.348986	-64.786418	Y	Y					?	?		0	0	0
CP-08-E	Y	18.342667	-64.707167	N	Y			45		Y	N		0	0-0.05	
CP-08-W(1)	Y	18.357650	-64.744517	N	N		5	11	12.5	N	Y		0.1-0.5	0.1-0.75	0.1-0.5
CP-08-W(2)	Y	18.357650	-64.744533	N	N		5	14	14	N	Y		0.1-0.2	0.1-0.2	0.1-0.2
CP-09-E	Y	Not sampled			Y										

Site	In VIIS	N	W	Dry	Isolated	Salinity (PSU)				Hypersaline	*Rhizophora*	Depth (m)			
						10/01	05/02	12/02	03/03			10/01	05/02	12/02	03/03
CP-09-W	Y	18.364983	-64.742933	N	Y			>100	33	Y	Y		0	0	0.1
CP-11-W	Y	18.351400	-64.769383	N	Y			4		N	Y		0	0.2	
CP-12-W	Y	18.354583	-64.754117	N	Y			6	30	N	Y		0	0	0.1
CP-13-E	Y	18.360300	-64.705883	N	Y				47	Y	Y				0.3
CP-14-E	Y	18.362317	-64.720667	N	Y			61		Y	Y		0	0.1	
CP-15-E	Y	18.363300	-64.735167	Y	Y					?	Y		0	0	0
CP-16-E	Y	Not sampled			Y										
CP-17-E	Y	18.322167	-64.745117	N	N			42	40	Y	Y			>1.5	>1.5
CP-18-E	Y	18.305883	-64.701767	N	Y			42	47	Y	Y			>1.0	>1.0
CP-19-E	Y	18.309617	-64.712417	N	Y			>100		Y	N			0.1	0
CP-20-E	Y	Not sampled			Y										
CP-23-E	Y	18.363300	-64.733050	N	N				8	N	Y				0.1-0.3
GP-01-E	Y	18.314750	-64.712450	N	N	0				N	N	0.1	0	0	0
GP-01-W-(1)	Y	18.331600	-64.743550	N	N	0	2	0	0-1	N	N	0.25-1.5	0.25-1.5	0.25-1.5	0.1-1.0
GP-01-W-(2)	Y	18.331617	-64.743550	N	N	0	2	0	0-1	N	N	0.25-1.5	0.25-1.5	0.25-1.5	0.1-1.0
GP-02-W	Y	18.323300	-64.758467	Y	N					?	N		0	0	0

GP-03-W(7)	Y	18.329867	-64.764560	N	N	0	0			N	N	0.2-0.8	0.2-0.8	0.2-0.8	0.1-0.5
GP-05-W	Y	18.356617	-64.739183	N	N			1.5		N	N			0.3	0.2
GP-06-W	Y	18.343038	-64.762776	Y	N					?	N		0	0	0
IP-01-W(1)	Y	18.342667	-64.785833	N	N		47	49		Y	N		0.1-0.8	0.1-0.8	0.1-0.8
IP-01-W(2)	Y	18.342633	-64.785833	N	Y		2			N	N		>2.0	>2.0	
IP-02-W	Y	Not sampled													
IP-03-E	Y	18.354000	-64.704167	Y	Y					?	N			0	
IP-03-W	Y	18.343433	-64.761467	Y	Y					?	N		0	0	0
IP-04-E	Y	18.348459	-64.683647	Y	Y					?	?		0	0	0
IP-04-W	Y	Not sampled													
IP-05-E	Y	18.346767	-64.681433	N	Y			43		Y	Y		0	0-0.2	0
IP-05-W	Y	18.344416	-64.761238	N	Y		0			N	N		0.1	0	0
IP-06-W	Y	18.322067	-64.758583	N	Y		0		2.5	N	N		>2.0		>2.0

B.

Site	In VIIS	N	W	Dry	Isolated	Salinity (PSU)				Hypersaline	*Rhizophora*	Depth (m)			
						10/01	05/02	12/02	03/03			10/01	05/02	12/02	03/03

CP-01-W	N	18.318317	-64.780567	N	Y		60	>100		Y	N	0.2-0.4		0
CP-02-W	N	18.315414	-64.784281	N	Y				37	Y	Y			>1.5
CP-03-W	N	18.318017	-64.784883	N	N	36	40	36	35.5	Y	Y	0.1-1.25	0.1-1.25	0.1-1.25
CP-04-W	N	Not sampled			Y		>100							
CP-05-W	N	Not sampled			Y									
CP-06-E	N	18.322400	-64.699583	N	Y			70	105	Y	N	0	0.1-0.2	
CP-06-W	N	Not sampled			Y		88							
CP-07-E	N	18.327433	-64.700817	N	Y				>110	Y	N	0		
CP-10-E	N				Y					Y	N		0.1->1.0	
		18.332783	-64.674617	N				>10 0	92					
CP-10-W	N	18.323295	-64.788109	N	N		44	56		Y	Y	0.1-1.0	0.1-1.0	0.1-1.0
CP-11-E	N	Not sampled			Y									
CP-12-E	N	Not sampled			Y									

CP-21-E-(1)	N	18.347200	-64.708483	N	N			45.5	47	Y	N			0.1	0-0.1
CP-21-E-(2)	N	18.347217	-64.708483	N	N			40		Y	Y			0.1	0
CP-22-E	N	18.345533	-64.716300	N	N				40	Y	Y			0	0.1-0.3
GP-03-W-(1)	N	18.329300	-64.764400	N	N	0	0	3.5	3.5	N	N	0.1-0.6	0.1-0.7	0.1-0.7	0.1-0.3
GP-03-W-(2)	N	18.329451	-64.764492	N	N	0	0	3.5	3.5	N	N	0.7	0.7	0.7	0.1-0.3
GP-03-W-(3)	N	18.329367	-64.764333	N	N	0	0	2.5	0	N	N	1	0.2-1.5	1	0.1-0.3
GP-03-W-(4)	N	18.329570	-64.764542	N	N	0	0	4	2	N	N	0.1-0.5	0.1-0.5	0.1-0.5	0.1-0.3
GP-03-W-(5)	N	18.329680	-64.764620	N	N	0	0	3	3	N	N	0.2-0.8	0.2-0.8	0.2-0.8	0.1-0.5
GP-03-W-(6)	N	18.329667	-64.764567	N	N	0	0	3	2.5	N	N	0.2-1.5	0.2-1.5	0.2-1.5	0.1-1.2
GP-04-W	N	18.325361	-64.784669	Y	N					?	N		0	0	0
IP-01-E	N	18.312800	-64.706917	N	Y		0			N	N		0.1->2.0	0	0
IP-02-E-(1)	N	18.346666	-64.724706	Y	N					?	N			?	
IP-02-E-(2)	N	18.343583	-64.723800	Y	N					?	N			0	

IP-06-E	N	18.341800	-64.673767	Y	Y		?	N		0	0	0

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Table 9. List of fishes recorded by collection or sight on St. John, USVI, including inland water of Virgin Islands National Park (VIIS) from 2001-2003. Habitats: CP-coastal pond; GP-gut pool; and IP-inland pond.

Family	Species	Common name	Habitat	In VIIS?
Carcharhinidae	Unid. Carcharhinid	Requiem shark	CP	
	Negaprion brevirostris	Lemon shark	CP	Y
Elopidae	*Elops saurus*	Ladyfish	CP	
	Megalops atlanticus	Tarpon	CP, IP	Y
Anguillidae	*Anguilla rostrata*	American eel	CP, GP	Y
Clupeidae	*Jenkinsia lamprotaenia*	Dwarf herring	CP	
Belonidae	*Strongylura* sp.	Needlefish	CP	
	Strongylura timucu	Timucu	CP	Y
Rivulidae	*Rivulus marmoratus*	Mangrove Rivulus	CP	Y
Atherinidae	*Atherinomorus stipes*	Hardhead silverside	CP	Y
Scorpaenidae	*Scorpaena grandicornis*	Plumed scorpionfish	CP	
Centropomidae	*Centropomus ensiferus*	Swordspine snook	CP	
	Centropomus undecimalis	Common snook	CP	
Echeneidae	Unid. echeneid	Remora	CP	Y
Carangidae	*Caranx latus*	Horse-eye jack	CP	Y
Lutjanidae	*Lutjanus apodus*	Schoolmaster snapper	CP, IP	Y
	Lutjanus griseus	Gray snapper	CP, IP	Y
Gerreidae	*Eugerres brasilianus*	Brazilian mojarra	CP	
	Eucinostomus sp.	Mojarra	CP	Y
	Eucinostomus jonesi	Slender mojarra	CP	Y
	Gerres cinereus	Yellowfin mojarra	CP	Y
Haemulidae	*Anisotremus virginicus*	Porkfish	CP	
Mullidae	*Mulloidichthys martinicus*	Yellow goatfish	CP	Y
Cichlidae	*Oreochromis mossambicus*	Mossambique tilapia	CP, IP	Y
Pomacentridae	*Abudefduf saxatilis*	Sergeant major	CP	
	Pomacentrus fuscus	Dusky damselfish	CP	
Mugilidae	*Agonostomus monticola*	Mountain mullet	GP, IP	Y
	Mugil sp.	Mullet	CP	
	Mugil curema	White mullet	CP, IP	Y
Sphyraenidae	*Sphyraena barracuda*	Great barracuda	CP	
Eleotridae	*Dormitator maculatus*	Fat sleeper	CP	Y
	Eleotris perniger	Spinycheek sleeper	CP	Y
	Erotelis smaragdus	Emerald sleeper	CP	Y
Gobiidae	Und. Gobiid	Goby	CP	Y
	Bathygobius soporator	Frillfin goby	CP	Y
	Evorthodus lyricus	Lyre goby	CP	Y
	Gobionellus boleosoma	Darter goby	CP	Y
	Lophogobius cyprinoides	Crested goby	CP	Y
	Sicydium plumieri	Sirajo goby	GP	Y
Tetraodontidae	*Sphoeroides testudineus*	Checkered puffer	CP	

Table 10. List of collection numbers by sampling location.

Site	In VIIS	Name/Area	N	W	October 01	May 02	December 02	March 03	Not Sampled
CP-01-E	Y	Europa Pond	18.319533	-64.732350		WFL-VI-02-02			
CP-02-E(1)	Y	Yawzi Point Pond	18.318245	-64.722227	WFL-VI-01-01	WFL-VI-02-03	WFL-VI-02-14	WFL-VI-03-04	
CP-02-E(2)	Y	Yawzi Point Pond	18.320467	-64.724500			WFL-VI-02-14	WFL-VI-03-05	
CP-03-E	Y	E of Great Lameshur	18.318433	-64.720000		WFL-VI-02-04			
CP-04-E	Y	Mandal Pond	18.314183	-64.712800		WFL-VI-02-05			
CP-05-E	Y	Salt Pond	18.307833	-64.704867	WFL-VI-01-05			WFL-VI-03-03	
CP-05-E(2)	Y	Little Salt pond (SW)	18.307217	-64.705833	WFL-VI-01-05			WFL-VI-03-03	
CP-06-E	N	Across from Calvary Church	18.322400	-64.699583				WFL-VI-03-16	
CP-07-E	N	N of Friis Bay	18.327433	-64.700817				WFL-VI-03-17	
CP-08-E	Y	Harbor Point Pond	18.342667	-64.707167			WFL-VI-02-26		
CP-09-E	Y	Turner Point Pond							No access
CP-10-E	N	Southside Pond	18.332783	-64.674617				WFL-VI-03-02	
CP-11-E	N	Privateer Bay							No access
CP-12-E	N	Newfound Bay							No access
CP-13-E	Y	Brown Bay Pond	18.360300	-64.705883				WFL-VI-03-18	
CP-14-E	Y	Leinster Bay	18.362317	-64.720667					Dry
CP-15-E	Y	Fredriksdal Mangroves	18.363300	-64.735167			WFL-VI-02-29		
CP-16-E	Y	N Shore - Please							No access
CP-17-E	Y	Reef Bay Mangroves	18.322167	-64.745117			WFL-VI-02-16		
CP-18-E	Y	Mangroves S of Salt Pond	18.305883	-64.701767			WFL-VI-02-15		
CP-19-E	Y	Kiddel Bay	18.309617	-64.712417			WFL-VI-02-25		
CP-20-E	Y	Fortsberg, E of Harbor Pt	18.309617	-64.712410					No access
CP-21-E-(1)	N	East Base, Coral Bay(E)	18.347200	-64.708483			WFL-VI-02-13a	WFL-VI-03-01	
CP-21-E-(2)	N	East Base, Coral Bay (W)	18.347217	-64.708483			WFL-VI-02-13a		
CP-22-E	N	Coral Bay Mangroves	18.345533	-64.716300				WFL-VI-03-06	

Site	In VIIS	Name/Area	N	W	October 01	May 02	December 02	March 03	Not Sampled
CP-23-E	Y	Mangroves near Annaberg	18.363300	-64.733050				WFL-VI-03-11	
GP-01-E	Y	Cob Gut	18.314750	-64.712450	WFL-VI-01-06				
IP-01-E	N	Concordia Ag Pond	18.312800	-64.706917		WFL-VI-02-06			
IP-02-E-(1)	N	Carolina (up gut)	18.346666	-64.724706					Dry
IP-02-E-(2)	N	King Hill Gut south branch	18.343583	-64.723800					Dry
IP-03-E	Y	Zootenvaal Pond	18.354000	-64.704167					Dry
IP-04-E	Y	Access through Elk Bay	18.348459	-64.683647					Dry
IP-05-E	Y	W of Haulover	18.346767	-64.681433			WFL-VI-02-13b		
IP-06-E	N	East End Pond	18.341800	-64.673767					Dry
CP-01-W	N	E of Chocolate Hole (Hart Bay)	18.318317	-64.780567		WFL-VI-02-08			
CP-02-W	N	E side of Chocolate Hole Shore	18.315414	-64.784281				WFL-VI-03-19	
CP-03-W	N	Chocolate Hole	18.318017	-64.784883	WFL-VI-01-04	WFL-VI-02-07	WFL-VI-02-21	WFL-VI-03-08	
CP-04-W	N	W. Chocolate Hole							Hypersaline
CP-05-W	N	Enighed Pond							Private
CP-06-W	N	Frank Bay (Gallow's Point)							Hypersaline
CP-07-W	Y	Turtle Point Pond	18.348986	-64.786418					Dry
CP-08-W(1)	Y	Maho Bay Mangrove Pond	18.357650	-64.744517		WFL-VI-02-12	WFL-VI_02-18	WFL-VI-03-09	
CP-08-W(2)	Y	Maho Bay Mangrove Pond	18.357650	-64.744533		WFL-VI-02-12	WFL-VI_02-18	WFL-VI-03-09	
CP-09-W	Y	Francis Bay Mangroves	18.364983	-64.742933			WFL-VI-02-28		
CP-10-W	N	Guinea Gut at Westin	18.323295	-64.788109			WFL-VI-02-22		
CP-11-W	Y	Trunk Bay Mangrove Pond	18.351400	-64.769383			WFL-VI-02-20		
CP-12-W	Y	Cinnamon Bay Pool	18.354583	-64.754117			WFL-VI_02-19	WFL-VI-03-15	
CP-13-W	N	Fish Bay Mangrove	18.321833	-64.761200			WFL-VI-02-23	WFL-VI-03-14	
GP-01-W-(1)	Y	Petroglyph Pool-Upper	18.331600	-64.743550	WFL-VI-01-03	WFL-VI-02-01	WFL-VI-02-17	WFL-VI-03-12	
GP-01-W-(2)	Y	Petroglyph Pool-Lower	18.331617	-64.743550	WFL-VI-01-03	WFL-VI-02-01	WFL-VI-02-17	WFL-VI-03-12	
GP-02-W	Y	"Mosquito Bridge" Gut	18.323300	-64.758467					Dry
GP-03-W(1)	N	Fish Bay Gut-Pool 1	18.329300	-64.764400	WFL-VI-01-02	WFL-VI-02-09	WFL-VI-02-24	WFL-VI-03-10	

Site	In VIIS	Name/Area	N	W	October 01	May 02	December 02	March 03	Not Sampled
GP-03-W(2)	N	Fish Bay Gut-Pool 2	18.329451	-64.764492	WFL-VI-01-02	WFL-VI-02-09	WFL-VI-02-24	WFL-VI-03-10	
GP-03-W(3)	N	Fish Bay Gut-Pool 3	18.329367	-64.764333	WFL-VI-01-02	WFL-VI-02-09	WFL-VI-02-24	WFL-VI-03-10	
GP-03-W(4)	N	Fish Bay Gut-Pool 4	18.329570	-64.764542	WFL-VI-01-02	WFL-VI-02-09	WFL-VI-02-24	WFL-VI-03-10	
GP-03-W(5)	N	Fish Bay Gut-Pool 5	18.329680	-64.764620	WFL-VI-01-02	WFL-VI-02-09	WFL-VI-02-24	WFL-VI-03-10	
GP-03-W(6)	N	Fish Bay Gut-Pool 6	18.329667	-64.764567	WFL-VI-01-02	WFL-VI-02-09	WFL-VI-02-24	WFL-VI-03-10	
GP-03-W(7)	Y	Fish Bay Gut-Pool 7	18.329867	-64.764560	WFL-VI-01-02	WFL-VI-02-09	WFL-VI-02-24	WFL-VI-03-10	
GP-04-W	N	Guinea Gut	18.325361	-64.784669					Dry
GP-05-W	Y	Maho Gut Pool	18.356617	-64.739183			WFL-VI-02-27		
GP-06-W	Y	Source of Battery Gut	18.343038	-64.762776					Dry
IP-01-W(1)	Y	Caneel Bay Run	18.342667	-64.785833		WFL-VI-02-10			
IP-01-W(2)	Y	Caneel Bay Polishing Pond	18.342633	-64.785833		WFL-VI-02-10			
IP-02-W	Y	Susannaberg Pond	18.341858	-64.770726					Private
IP-03-W	Y	Pond at Katherineberg	18.343433	-64.761467					Dry
IP-04-W	Y	S.Rt. 10, w. Reef Bay Trail							Not there
IP-05-W	Y	Cistern at Katherineberg	18.344416	-64.761238		WFL-VI-02-11b			Dry
IP-06-W	Y	Pond at East Fish Bay Gut	18.322067	-64.758583		WFL-VI-02-11a		WFL-VI-03-13	

Table 11. Listing of fishes, their sizes (mm SL), and locations of capture during four visits to St. John from 2001 to 2003. Some fishes were not collected (sight) or were too small for positive identification – these are listed only as family or genus.

Collection	Site	Date	Species	Lth1	Lth2	Lth3	Lth4	Lth5	Lth6	Lth7	Lth8	Lth9
WFL-VI-01-01	CP-02-E(1)	20 Oct 03	*Megalops atlanticus*	Sight								
WFL-VI-01-01	CP-02-E(1)	20 Oct 03	*Gerres cinereus*	Sight								
WFL-VI-01-01	CP-02-E(1)	20 Oct 03	*Lutjanus apodus*	Sight								
WFL-VI-01-01	CP-02-E(1)	20 Oct 03	*Lutjanus griseus*	Sight								
WFL-VI-01-02	GP-03-W(1)	20 Oct 03	No fish	Sight								
WFL-VI-01-02	GP-03-W(2)	21 Oct 03	*Agonostomus monticola*	Sight (Photo)								
WFL-VI-01-02	GP-03-W(2)	21 Oct 03	*Anguilla rostrata*	Sight								
WFL-VI-01-02	GP-03-W(3)	21 Oct 03	*Agonostomus monticola*	Sight								
WFL-VI-01-02	GP-03-W(4)	21 Oct 03	*Agonostomus monticola*	Sight								
WFL-VI-01-02	GP-03-W(5)	21 Oct 03	*Agonostomus monticola*	Sight								
WFL-VI-01-02	GP-03-W(6)	21 Oct 03	*Agonostomus monticola*	Sight								
WFL-VI-01-03	GP-01-W(2)	22 Oct 03	*Agonostomus monticola*	Sight (Photo)								
WFL-VI-01-04	CP-03-W	23 Oct 03	*Eucinostomus sp.*	Sight								
WFL-VI-01-04	CP-03-W	23 Oct 03	*Gerres cinereus*	Sight								
WFL-VI-01-04	CP-03-W	23 Oct 03	*Sphoeroides testudineus*	Sight								
WFL-VI-01-04	CP-03-W	23 Oct 03	*Lutjanus apodus*	Sight								
WFL-VI-01-04	CP-03-W	23 Oct 03	*Bathygobius Sp.*	Sight								
WFL-VI-01-04	CP-03-W	23 Oct 03	*Strongylura sp.*	Sight								
WFL-VI-01-04	CP-03-W	23 Oct 03	*Mugil* sp.	Sight								
WFL-VI-01-05	CP-05-E(2)	23 Oct 03	No fish	Sight								
WFL-VI-01-06	GP-01-E	20 Oct 01	No fish	Sight								
WFL-V1-02-01	GP-01-W(1)	16 May 02	*Agonostomus monticola*	Sight								
WFL-V1-02-01	GP-01-W(2)	16 May 02	*Agonostomus monticola*	Sight								
WFL-V1-02-02	CP-01-E	16-17 May 02	No fish	Trap								
WFL-V1-02-03	CP-02-E(1)	16-17 May 02	*Megalops atlanticus*	Angling								
WFL-V1-02-03	CP-02-E(1)	16-17 May 02	*Mugil curema*	29.0	38.0	29.0	30.0	33.0				
WFL-V1-02-03	CP-02-E(1)	16-17 May 02	*Lutjanus apodus*	Sight								
WFL-V1-02-03	CP-02-E(1)	16-17 May 02	*Eleotris perniger*	29.0	34.7	40.5		41.7				
WFL-V1-02-03	CP-02-E(1)	16-17 May 02	*Lutjanus griseus*	29.0	28.0	20.0	17.0	17.0	16.5	16.0	15.0	13.5
WFL-V1-02-03	CP-02-E(1)	16-17 May 02	*Gobionellus boleosoma*	36.0	34.0	37.0	32.7	29.8	30.0	25.2	30.0	29.8
				36.2	23.9							

Table 7. Continued

Collection	Site	Date	Species	Lth1	Lth2	Lth3	Lth4	Lth5	Lth6	Lth7	Lth8	Lth9
WFL-V1-02-04	CP-03-E	16 May 02	*Gerres cinereus*	89.1			93.7					
WFL-V1-02-05	CP-04-E	16 May 02	No Fish	Sight								
WFL-V1-02-06	Ip-01-E	16 May 02	No Fish	Trap, Seine, Sight								
WFL-V1-02-07	CP-03-W	19 May 02	*Lophogobius cyprinoides*	52.0	43.7	31.9	51.2	38.3	32.2			
WFL-V1-02-07	CP-03-W	20 May 02	*Pomacentrus fuscus*	52.8								
WFL-V1-02-07	CP-03-W	20 May 02	*Bathygobius soporator*	70.5	55.7	43.6	45.9					
WFL-V1-02-07	CP-03-W	20 May 02	*Sphoeroides testudineus*	Sight								
WFL-V1-02-07	CP-03-W	19 May 02	*Megalops atlanticus*	Sight								
WFL-V1-02-07	CP-03-W	19 May 02	*Strongylura sp.*	Sight								
WFL-V1-02-08	CP-01-W	19 May 02	No fish	Trap								
WFL-V1-02-09	GP-03-W(1)	19-20 May 02	*Eleotris perniger*	84.9	100.8	80.0						
WFL-V1-02-09	GP-03-W(1)	19-20 May 02	*Anguilla rostrata*	280.0 - Released								
WFL-V1-02-09	GP-03-W(1)	19-20 May 02	*Agonostomus monticola*	Sight	(>24)	28.4	31.8					
WFL-V1-02-09	GP-03-W(2)	19-20 May 02	*Agonostomus monticola*	Sight								
WFL-V1-02-09	GP-03-W(3)	19-20 May 02	*Agonostomus monticola*	Sight								
WFL-V1-02-09	GP-03-W(4)	19-20 May 02	*Agonostomus monticola*	44.0	35.5	27.0	30.6					
WFL-V1-02-09	GP-03-W(5)	19-20 May 02	*Sicydium plumieri*	21.0								
WFL-V1-02-09	GP-03-W(5)	19-20 May 02	*Agonostomus monticola*	Sight								
WFL-V1-02-09	GP-03-W(6)	19-20 May 02	*Agonostomus monticola*	Sight								
WFL-V1-02-10	IP-01-W(1)	20-21May 02	*Lutjanus apodus*	Sight (Adult)								
WFL-V1-02-10	IP-01-W(1)	20-21May 02	*Lutjanus griseus*	Sight (Subadult)								
WFL-V1-02-10	IP-01-W(1)	20-21May 02	*Agonostomus monticola*	70.0	65.0	72.0	72.0	67.0				
WFL-V1-02-10	IP-01-W(1)	20-21May 02	*Mugil curema*	109.0	72.5	75.5	51.7	53.7	54.4	34.2	38.1	53.0
WFL-V1-02-10	IP-01-W(1)	20-21May 02	*Oreochromis mossambicus*	113.0	91.0	98.7	85.3	91.0	91.1	98.1		
WFL-V1-02-10	IP-01-W(2)	21-22 May 02	*Oreochromis mossambicus*	26.7	20.4	17.2	13.6					
WFL-V1-02-11a	IP-06-W	20 May 02	*Megalops atlanticus*	Sight								
WFL-V1-02-11b	IP-05-W	21 May 02	No fish	Net								
WFL-V1-02-12	CP-08-W (2)	21-22 May 02	*Rivulus marmoratus*	34.7	42.7	33.0	23.1	30.5	30.6			
WFL-V1-02-12	CP-08-W (1)	21-22 May 02	*Anguilla rostrata*	106.7	333.3	(TL)						
WFL-V1-02-12	CP-08-W (1)	21-22 May 02	*Eleotris perniger*	68.4	59.9	67.8	68.5	71.1	65.4	63.6	59.2	56.0
				44.6	64.0	41.2	60.7	60.5				
WFL-V1-02-12	CP-08-W (1)	21-22 May 02	*Dormitator maculatus*	87.0								
WFL-V1-02-13a	CP-21-E(1/2)	7-10 Dec 02	*Gobionellus boleosoma*	29.3	21.1	26.3	21.7	23.0	21.9	20.6	30.2	36.2

Table 7. Continued

Collection	Site	Date	Species	Lth1	Lth2	Lth3	Lth4	Lth5	Lth6	Lth7	Lth8	Lth9
				33.0	26.5	35.8	47.1	39.0	42.8	29.0	29.6	18.5
			G. boleosoma (continued)	43.1	28.9	26.4	28.9	25.6	18.2			
WFL-V1-02-13a	CP-21-E(1/2)	7-10 Dec 02	*Evorthodus lyricus*	19.9	29.6	33.5	48.3	35.3	35.8	30.3	22.4	55.7
				27.3	25.4	29.0	19.1	53.2	39.8	30.2	44.9	
WFL-V1-02-13a	CP-21-E(1)	7-10 Dec 02	*Eucinostomus sp.*	18.8	29.9	22.8	18.8	24.0	18.4			
WFL-V1-02-13a	CP-21-E(1/2)	7-10 Dec 02	*Gerres cinereus*	15.9	20.2	29.6	15.1	15.2	15.9	18.4	15.7	24.3
				32.0	30.8	34.9	23.5	28.3	26.0			
WFL-V1-02-13a	CP-21-E(1)	7-10 Dec 02	*Eugerres brasilianus*	26.0								
WFL-V1-02-13a	CP-21-E(2)	7-10 Dec 02	*Erotelis smaragdus*	39.7								
WFL-V1-02-13a	CP-21-E(1)	7-10 Dec 02	*Sphyraena barracuda.*	Sight - ~100.0								
WFL-V1-02-13b	IP-05-E	7-8 Dec 02	No Fish	Trap								
WFL-V1-02-14	CP-02-E(1/2)	7-8 Dec 02	*Mugil curema*	32.1	30.5	32.0						
WFL-V1-02-14	CP-02-E(1)	7-8 Dec 02	*Strongylura timucu*	300.7	320.2							
WFL-V1-02-14	CP-02-E(2)	7-8 Dec 02	*Caranx latus*	159.9	122.5	67.4	60.5					
WFL-V1-02-14	CP-02-E(1)	7-8 Dec 02	*Evorthodus lyricus*	19.2								
WFL-V1-02-14	CP-02-E(2)	7-8 Dec 02	*Lophogobius cyprinoides*	32.0	30.2							
WFL-V1-02-14	CP-02-E(1)	7-8 Dec 02	*Gobionellus boleosoma*	31.7								
WFL-V1-02-14	CP-02-E(2)	7-8 Dec 02	*Lutjanus griseus*	92.2	55.0							
WFL-V1-02-14	CP-02-E(2)	7-8 Dec 02	*Lutjanus apodus*	74.5	68.8	80.8						
WFL-V1-02-14	CP-02-E(2)	7-8 Dec 02	*Atherinomorus stipes*	19.9	32.1	49.0	33.8	28.4	49.8	44.1		
WFL-V1-02-14	CP-02-E(1)	7-8 Dec 02	Unid. gobiid	24.0								
WFL-V1-02-14	CP-02-E(1/2)	7-8 Dec 02	*Gerres cinereus*	31.5	25.8	26.3	32.7	22.2	32.4	31.3	34.2	22.3
				25.0	33.7	40.7	18.8	44.7	32.5	51.6	70.8	52.0
				44.4	59.0							
WFL-V1-02-14	CP-02-E(2)	7-8 Dec 02	Unid. carcharhinid	~750 (probably *C. limbatus)*								
WFL-V1-02-14	CP-02-E(2)	7-8 Dec 02	*Mulloides martinicus*	Sight								
WFL-V1-02-14	CP-02-E(2)	7-8 Dec 02	Unid. echeneid	Sight								
WFL-V1-02-15	CP-18-E	8-9 Dec 02	No fish	Trap								
WFL-V1-02-16	CP-17-E	9-10 Dec 02	*Megalops atlanticus*	Sight								
WFL-V1-02-17	GP-01-W(1)	9-10 Dec 02	*Anguilla rostrata*	333.4								
WFL-V1-02-18	CP-08-W(1)	10-11 Dec 02	No fish	Trap								
WFL-V1-02-18	CP-08-W(2)	10-11 Dec 02	*Rivulus marmoratus*	40 total	45.0	32.7	26.7	24.8	20.8	29.0	23.6	51.8
				39.5								

WFL-V1-02-19	CP-12-W(2)	11-12 Dec 02	No fish	Trap

Table 5. Continued

Collection	Site	Date	Species	Lth1	Lth2	Lth3	Lth4	Lth5	Lth6	Lth7	Lth8	Lth9
WFL-V1-02-20	CP-11-W	10-11 Dec 02	*Rivulus marmoratus*	39 total	52.8	48.4	42.4	36.8	32.0	36.4		
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Mugil curema*	Sight								
WFL-V1-02-21	CP-03-W	11-13 Dec 02	Unid. carcharhinid	Sight (maybe *C. limbatus)*								
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Abudefduf saxatilis*	Sight								
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Anisotremus virginianus*	Sight								
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Megalops atlanticus*	Sight								
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Gerres cinereus*	24.5								
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Lutjanus apodus*	61.0								
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Lophogobius cyprinoides*	37.6	29.8	42.2						
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Sphoeroides testudineus*	120.0								
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Scorpaena grandicornis*	43.5								
WFL-V1-02-21	CP-03-W	11-13 Dec 02	*Bathygobius soporator*	74.1	46.0	45.0	53.2					
WFL-V1-02-22	CP-10-W	12-13 Dec 02	*Mugil curema*	48.8	30.6	30.1						
WFL-V1-02-22	CP-10-W	12-13 Dec 02	*Lutjanus griseus*	Sight								
WFL-V1-02-22	CP-10-W	12-13 Dec 02	*Gerres cinereus*	15.2	14.3							
WFL-V1-02-23	CP-13-W	13 Dec 02	*Mugil curema*	19.7	21.7	20.5	29.0	21.6	21.9	21.4	22.7	22.6
WFL-V1-02-23	CP-13-W	13 Dec 02	*Gerres cinereus*	14.5	14.8	18.7	15.5	16.9	16.9	13.1	15.2	16.8
				15.5	16.4	13.6	11.9	12.1	11.9	9.4		
WFL-V1-02-24	GP-03-W(1)	12-13 Dec 02	*Agonostomus monticola*	Sight								
WFL-V1-02-24	GP-03-W(1)	12-13 Dec 02	*Eleotris perniger*	81.3								
WFL-V1-02-24	GP-03-W(2)	12-13 Dec 02	*Agonostomus monticola*	Sight								
WFL-V1-02-24	GP-03-W(3)	12-13 Dec 02	*Agonostomus monticola*	Sight								
WFL-V1-02-24	GP-03-W(4)	12-13 Dec 02	*Agonostomus monticola*	128.9								
WFL-V1-02-24	GP-03-W(4)	12-13 Dec 02	*Sicydium plumieri*	37.6								
WFL-V1-02-24	GP-03-W(5)	12-13 Dec 02	*Sicydium plumieri*	38.2								
WFL-V1-02-24	GP-03-W(5)	12-13 Dec 02	*Agonostomus monticola*	Sight								
WFL-V1-02-24	GP-03-W(6)	12-13 Dec 02	*Agonostomus monticola*	Sight								
WFL-V1-02-25	IP-01-W(1)	12 Dec 02	*Oreochromis mossambicus*	Sight								
WFL-V1-02-25	IP-01-W(1)	12 Dec 02	*Mugil curema*	Sight								
WFL-V1-02-25	IP-01-W(1)	12 Dec 02	*Agonostomus monticola*	Sight								
WFL-V1-02-25	IP-01-W(1)	12 Dec 02	*Lutjanus apodus*	Sight								

WFL-V1-02-26	CP-08-E	8 Dec 02	No fish	Sight
WFL-V1-02-27	GP-05-W	11-12 Dec 02	No fish	Sight

Table 7. Continued

Collection	Site	Date	Species	Lth1	Lth2	Lth3	Lth4	Lth5	Lth6	Lth7	Lth8	Lth9
WFL-V1-02-28	CP-09-W	10 Dec 02	No fish	Sight								
WFL-V1-02-29	CP-14-E	10 Dec 02	No fish	Sight								
WFL-V1-03-01	CP-21-E	22-23 Mar 03	*Mugil curema*	95.5	104.1	131.5						
WFL-V1-03-01	CP-21-E	22-23 Mar 03	*Gerres cinereus*	65.1								
WFL-V1-03-01	CP-21-E	22-23 Mar 03	*Elops saurus*	159.0	201.0							
WFL-V1-03-01	CP-21-E	22-23 Mar 03	*Centropomus ensiferus*	110.0								
WFL-V1-03-01	CP-21-E	22-23 Mar 03	*Centropomus undecimalis*	166.0	157.8							
WFL-V1-03-02	CP-10-E	22 Mar 03	No fish	Trap								
WFL-VI-03-03	CP-05-E	22 Mar 03	No fish	Trap								
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Negaprion brevirostris*	900.0 TL								
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Mugil curema*	135.7								
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Lutjanus griseus*	136.7								
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Caranx latus*	78.8								
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Lophogobius cyprinoides*	58.2	49.2							
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Erotelis smaragdus*	43.5								
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Bathygobius soporator*	54.0	74.5	78.0						
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Gobionellus boleosoma*	26.7								
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Gerres cinereus*	70.0								
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Eucinostomus jonesi*	98.0								
WFL-V1-03-04	CP-02-E(1)	23-24 Mar 03	*Megalops atlanticus*	Sight								
WFL-V1-03-05	CP-02-E(2)	23-24 Mar 03	*Rivulus marmoratus*	30.8								
WFL-V1-03-05	CP-02-E(2)	23-24 Mar 03	*Mugil curema*	29.3								
WFL-V1-03-06	CP-22-E	23-24 Mar 03	*Rivulus marmoratus*	28.0	25.0	21.0						
WFL-V1-03-07	CP-17-E	23-24 Mar 03	*Rivulus marmoratus*	42.0								
WFL-V1-03-07	CP-17-E	23-24 Mar 03	*Megalops atlanticus*	Sight								
WFL-V1-03-08	CP-03-W	25-26 Mar 03	*Strongylura timucu*	Sight								
WFL-V1-03-08	CP-03-W	25-26 Mar 03	*Sphoeroides testudineus*	Sight								
WFL-V1-03-08	CP-03-W	25-26 Mar 03	*Mugil curema*	32.5 (+ 4 adults >300.0 mm SL in gill net)								
WFL-V1-03-08	CP-03-W	25-26 Mar 03	*Lophogobius cyprinoides*	39.1	20.0							
WFL-V1-03-08	CP-03-W	25-26 Mar 03	*Gerres cinereus*	39.2								
WFL-V1-03-08	CP-03-W	25-26 Mar 03	*Jenkinsia lamprotaenia*	46.1								

WFL-V1-03-09	CP-08-W(1)	26-27 Mar 03	*Rivulus marmoratus*	47.0	37.0	27.0	20.0	16.0				
WFL-V1-03-09	CP-08-W(1)	26-27 Mar 03	*Eleotris perniger*	71.0	125.0							
WFL-VI-03-09	CP-08-W(2)	26-27 Mar 03	No fish	Trap								

Table 7. Continued

Collection	Site	Date	Species	Lth1	Lth2	Lth3	Lth4	Lth5	Lth6	Lth7	Lth8	Lth9
WFL-V1-03-10	GP-03-W(1)	27-28 Mar 03	*Anguilla rostrata*	210.0	230.0							
WFL-V1-03-10	GP-03-W(1)	27-28 Mar 03	*Eleotris perniger*	91.0	93.0	81.0	76.0					
WFL-V1-03-10	GP-03-W(2)	27-28 Mar 03	*Anguilla rostrata*	75.0								
WFL-V1-03-10	GP-03-W(3)	27-28 Mar 03	*Agonostomus monticola*	Sight								
WFL-V1-03-10	GP-03-W(4)	27-28 Mar 03	*Agonostomus monticola*	Sight								
WFL-V1-03-10	GP-03-W(5)	27-28 Mar 03	*Agonostomus monticola*	Sight								
WFL-V1-03-10	GP-03-W(5)	27-28 Mar 03	*Sicydium plumieri*	Sight								
WFL-V1-03-10	GP-03-W(6)	27-28 Mar 03	*Agonostomus monticola*	Sight								
WFL-V1-03-10	GP-03-W(6)	27-28 Mar 03	*Sicydium plumieri*	Sight								
WFL-V1-03-10	GP-03-W(7)	27-28 Mar 03	*Agonostomus monticola*	Sight								
WFL-VI-03-10	GP-03-W(7)	27-28 Mar 03	*Sicydium plumieri*	Sight								
WFL-V1-03-11	CP-22-E	27-28 Mar 03	*Rivulus marmoratus*	20.0	26.0	32.0	40.0					
WFL-V1-03-12	GP-01-W(1)	24-25 Mar 03	No fish	Trap								
WFL-V1-03-12	GP-03-W(2)	24-25 Mar 03	No fish	Trap								
WFL-V1-03-13	IP-06-W	26 Mar 03	*Megalops atlanticus*	Sight								
WFL-VI-03-14	CP-13-W	27-28 Mar 03	No fish	Trap								
WFL-V1-03-15	CP-12-W	27-28 Mar 03	No fish	Trap								
WFL-V1-03-16	CP-06-E	23 Mar 03	No fish	Sight								
WFL-V1-03-17	CP-07-E	23 Mar 03	No fish	Sight								
WFL-V1-03-18	CP-13-E	22 Mar 03	No fish	Sight								
WFL-V1-03-19	CP-02-W	26 Mar 03	*Gerres cinereus*	Sight								
WFL-V1-03-19	CP-02-W	26 Mar 03	*Mugil curema*	Sight								
WFL-V1-03-19	CP-02-W	26 Mar 03	*Lutjanus apodus*	Sight								
WFL-V1-03-19	CP-02-W	26 Mar 03	*Abudefduf saxatilis*	Sight								
WFL-V1-03-19	CP-02-W	26 Mar 03	*Strongylura* sp.	Sight								

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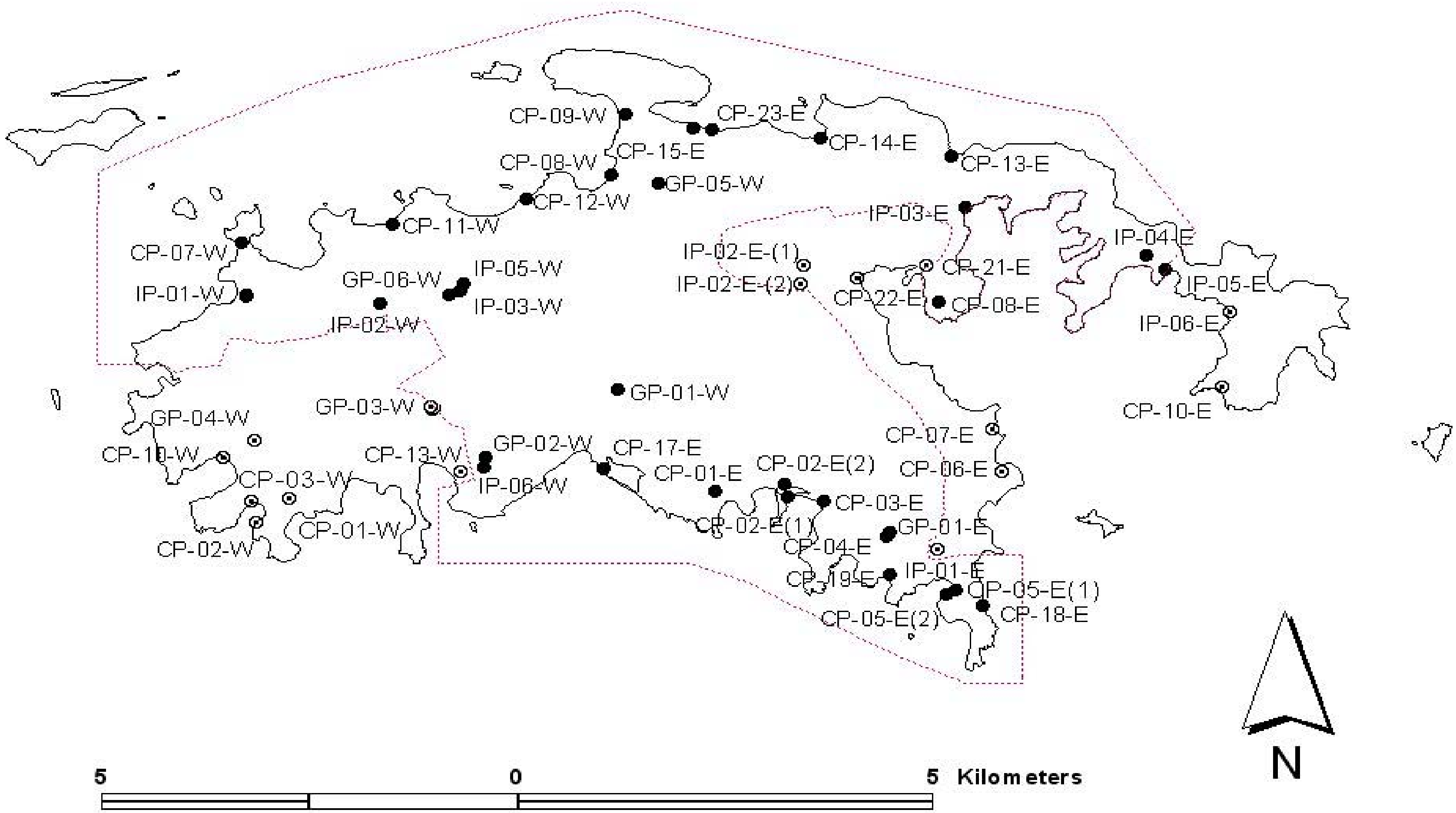

CP-09-W
CP-23-E
CP-14-E
CP-13-E
CP-08-W
CP-15-E
CP-12-W
GP-05-W
CP-11-W
IP-03-E
IP-04-E
CP-07-W
IP-02-E-(1)
IP-02-E-(2)
CP-21-E
IP-05-E
IP-01-W
GP-06-W
IP-05-W
IP-03-W
CP-22-E
CP-08-E
IP-06-E
IP-02-W
GP-01-W
CP-10-E
GP-03-W
GP-04-W
CP-07-E
CP-10-W
GP-02-W
CP-17-E
CP-13-W
CP-01-E
CP-02-E(2)
CP-06-E
CP-03-W
IP-06-W
CP-03-E
CP-01-W
CP-02-E(1)
GP-01-E
CP-02-W
CP-04-E
CP-19-E
IP-01-E
CP-05-E(1)
CP-05-E(2)
CP-18-E
5
0
5 Kilometers
N

Photos were deleted for files compression.

Figure 2. Above
Figure 3. Below

Photos were deleted for files compression.

Figure 4. Above
Figure 5. Below

Figure 6. Above
Figure 7 Below

Figure 8. Above
Figure 9 Below

Figure 10. Above
Figure 11. Below

Figure 12
Figure 13